F. C. Schrader

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CHAS. N. GOULD, Director

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INDEX
TO THE
STRATIGRAPHY of OKLAHOMA

By
CHAS. N. GOULD

With Lists of
CHARACTERISTIC FOSSILS
By CHARLES E. DECKER

NORMAN
SEPTEMBER, 1925

INDEX TO THE STRATIGRAPHY OF OKLAHOMA

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By Charles E. Decker

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FOREWORD

OCCASION

The occasion for the presentation of a much-needed report on the stratigraphy of Oklahoma may be found in the publication of the colored geologic map of the State, compiled by Mr. Hugh D. Miser, of the United States Geological Survey.

THE GEOLOGIC MAP OF OKLAHOMA

This map has been in process of compilation for two years and will be published by the Federal Survey. The compilation has been finished at this time (June, 1925), but the map will not be published before 1926. The map has been prepared in co-operation with the geologists of Oklahoma, represented by Sidney Powers; the oil companies of Oklahoma; and the Oklahoma Geological Survey, of which Professor Charles E. Decker was the co-operating official for the map project. The co-operation of the United States Geological Survey with the Oklahoma geologists and oil companies was through the National Research Council. The map was compiled from published maps, maps in the records of the United States and Oklahoma Geological Surveys, data furnished by the oil companies and consulting geologists, and some field data obtained by Mr. Miser. The unpublished maps that were furnished by Oklahoma geologists and companies cover about one-third of the State, the unpublished maps from the Federal and State Geological Surveys cover the second third, and published maps cover only the last third. The new State map will, therefore present new data for more than one-half of the State. The total number of used maps that have been obtained from all sources is about 1,000.

The geologic drafting has been done by Lewis B. Pusey, Otis F. Mack, Nevin B. Johnson, and Mrs. Bess Mills-Bullard. The total time devoted to the map by these draftsmen is equivalent to the full working time of one draftsman for about two years.

ACKNOWLEDGMENTS

The writer is under great obligation to the following persons: To Prof. G. E. Anderson, who aided in preparing the manuscript on the Ozark Mountains and the Pennsylvanian of Northern Oklahoma; to Prof. Charles E. Decker, who has supplied the lists of characteristic fossils; to Mr. H. D. Miser, who has constantly been free with constructive criticism; and to Miss M. Grace Wilmarth, Secretary of the Committee of Geologic Names

of the United States Geological Survey, who has read the manuscript and has added many pertinent suggestions. Whatever merit this Index may have is due in a large part to the helpful advice of these fellow workers.

PREVIOUS WORK

Heretofore no attempt has been made to publish a complete list of the geological formations of the State as a whole. As early as 1911 the present writer[1] prepared a brief statement of the geological history of Oklahoma. Hutchison,[2] the same year, described briefly the rocks of the four mountain uplifts, and the Pennsylvanian and Permian series. Shannon and Trout[3] in 1915 listed the principal Pennsylvanian, Permian and Cretaceous formations. Other articles have appeared from time to time dealing with certain phases of the problem, but no complete discussion has ever been attempted.

THE PROBLEM

Oklahoma has about the hardest geology outdoors. If you don't believe it take a look at the geologic map. Also witness the fact that it has taken 30 years to get together the data for even such an elementary glossary of the formations of the State as this bulletin pretends to be. Our ignorance of many of the crucial points of Oklahoma geology is, at this date, very profound. Scores of problems yet cry for solution.

Oklahoma stratigraphy stands upon three legs, namely the double Arbuckle-Wichita leg, the Ouachita leg and the Ozark leg. Igneous rocks are exposed in all four of these mountain uplifts, and granite, probably pre-Cambrian in age, in three of them.

The stratigraphic succession in the Arbuckles and Wichitas appears to be identical. In the Wichitas, however, pre-Permian erosion has removed many of the Paleozoic sediments near the periphery of the uplift, and Permian deposition has concealed practically all the older sedimentary formations except isolated exposures of the Reagan, Arbuckle, and Viola formations. For this reason, except for brief mention in connection with the stratigraphy of the Arbuckles, the stratigraphy of the Wichitas need scarcely be referred to.

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[1]Gould, Chas. N., Brief statement of the Geological History of Oklahoma. Oklahoma Geological Survey, Circular No. 2, 1911.

[2]Hutchison, L. L., Rock Asphalt, Asphaltite, Petroleum and Natural Gas in Oklahoma, Oklahoma Geological Survey, Bulletin No. 2, 1911.

[3]Shannon, C. W., & Trout, L. E., Petroleum and Natural Gas in Oklahoma, Oklahoma Geological Survey, Bulletin No. 19, part I, 1915.

Very different, however, are conditions in the other three mountain uplifts. In each case there are exposed Paleozoic sedimentary rocks ranging in age from Cambrian to Pennsylvanian. Yet the three sections are almost absolutely different. With the exception of the Wapanucka limestone, Caney shale, Woodford chert, and possibly the Sycamore limestone, which formations occur in both the Arbuckles and Ouachitas, no mappable unit has yet been found in any one of these three mountain uplifts which is also known to occur in either of the other two.

Volumes might be written on this subject, and as the years come and go doubtless such volumes will be written, but the limits of this article preclude full discussion.

TREATMENT

Even at the outset of the preparation of a feasible scheme for presenting the stratigraphy of Oklahoma the geologist finds himself embarrassed. In most of the States of the plains, Kansas, for instance, one simply starts at the oldest or lowest formation and methodically walks upstairs, step by step, until his task has been completed, and then quietly tucks the various formations away under the blanket of Tertiary and Pleistocene. Not so in Oklahoma. There is no such orderly succession of formations in our State. In order to avoid glaring error the stratigrapher must here call to his aid all the expert help he can secure—the paleontologist, the petrographer, the sedimentationist, and the subsurface worker, and even then these wise men do not always agree; witness, for instance the Jackfork-Caney-Wapanucka-Morrow-Atoka problem, the Cherokee-Winslow problem, the Glenn problem, or the Wellington-Enid-Wichita-Clear Fork problem, all of which, and many others are today unsolved. Doubtless some future geologist, with the advantage of more quantitive work, will devise a more logical plan for the treatment of the subject than the one here presented. Until this has been accomplished, however, the following plan must suffice.

The treatment of the subject will be as follows:

1. The stratigraphy of the Arbuckle and Wichita mountains, including the Glenn formation.

2. The stratigraphy of the Ouachita Mountains continuing through the Carboniferous of southeastern Oklahoma as far as the Permian red beds.

3. The stratigraphy of the Ozark Mountains of northeastern Oklahoma continuing through the Pennsylvanian of northern Oklahoma and the basal Permian into the red beds.

4. The stratigraphy of the Permian beginning with the Wichita-Clear Fork-Enid beds.

5. The stratigraphy of the Cretaceous of southern Oklahoma.

6. The stratigraphy of the Panhandle country.

7. The Tertiary and Quaternary.

In the matter of citations to literature no attempt has been made to present complete bibliographies, but rather to call attention only to a few of the more important publications dealing with the various formations. Mr. Miser has revised this part of the manuscript. The most complete bibliography of Oklahoma geology so far written was prepared by Mr. F. L. Aurin and George H. Myers, and published as Bulletin No. 25 of this Survey.

It is most certainly not the purpose of the writer at this time to attempt to discuss mooted points of age or correlation, but merely to present, in so far as possible, the current consensus of opinion regarding the various problems. In case of difference of views the plan has been to follow as closely as possible the judgment of the Committee of Geologic Names of the United States Geological Survey as presented by Miss Wilmarth and Mr. Miser.

Very possibly before this report is in type new discoveries may be made which will cause a change of correlation or of mapping. Almost certainly new data, which are constantly being secured by scores of working geologists throughout the State, will from time to time cause a modification of many of our present views. However, if we wait until all possible information has been collected, digested, and recorded this book will never go to press.

This then is the writer's foreword—"Here is a target to be shot at."

ARBUCKLE AND WICHITA MOUNTAIN SECTION

IGNEOUS ROCKS

In the Arbuckle Mountains igneous rocks occur in three areas; namely, a triangular area, occupying approximately 100 square miles, north of Tishomingo, Johnston County; and two small areas, known as the East Timbered Hills and the West Timbered Hills, in western Murray County.

In the Tishomingo area the rock is largely a coarse-grained, pinkish granite (Tishomingo granite) associated with quartz-monzonite, aplite, and granite porphyry, cut with dikes of various basic materials. In the East Timbered Hills and West Timbered Hills the rock is chiefly porphyry (the Colbert porphyry of C. A. Reeds, 1910), consisting largely of pink feldspar phenocrysts in a reddish to gray groundmass, cut by numerous diabase dikes.

The Tishomingo granite was named by R. T. Hill in 1891. Its type locality is Tishomingo, county seat of Johnston County, which is located on the granite. It is generally regarded as of pre-Cambrian age.

In the Wichita Mountains, Taylor finds a small area of pre-Cambrian sedimentary quartzite and sandstone (unnamed)—older than the gabbro and granite, which rocks make up the mass of the mountains. Successive intrusions of gabbro and granite followed at unknown intervals. The various granites have been named in ascending order of age, Headquarters, Reformatory, Lugart-Mt. Scott, Cold Springs, and Elk Mountain. These various granite masses have been cut by numerous dikes of diabase, pegmatite, quartz diorite, granite, and diabase-diorite.

CITATIONS:

Taff, J. A., U. S. Geol. Survey, Geol. Atlas, Atoka folio (No. 79), 1902, and Tishomingo folio (No. 98), 1903. Preliminary Report on the Geology of the Arbuckle and Wichita Mountains in Indian Territory and Oklahoma; U. S. Geol. Survey, Prof. Paper 31, 1904.

Gould, C. N., Geology and Water Resources of Oklahoma; U. S. Geol. Survey, Water-Supply Paper 148, 1905.

Taylor, C. H., Granites of Oklahoma: Okla. Geol. Survey, Bull. 20, 1915.

REAGAN SANDSTONE

NOMENCLATOR: J. A. Taff, 1902.

TYPE LOCALITY: Hamlet of Reagan, 10 miles north of Tishomingo, Johnston County, Oklahoma.

CHARACTER: A variable formation as regards both thickness and nature of material. Taff's description from Tishomingo folio follows:

"The lower part, in contact with the granite, where the formation is thickest, is poorly sorted, coarse, granitic material composed chiefly of grains of quartz with some feldspar. This basal arkose member is variable in occurrence as well as in thickness, and in places is absent altogether, allowing the purer sandstone beds, higher in the section, to rest in contact with the granite. The middle part is composed chiefly of quartz grains, varying in size from that of a pea to fine particles. The upper portion is a calcareous and shaly sandstone, successive beds of which become more limy upward until the purer limestone of the Arbuckle formation is reached."

THICKNESS: From a few feet to 500 feet; average about 300 feet.

OCCURENCE: The Reagan occurs unconformably above the granite. In the Arbuckle Mountains it is exposed in three general regions; namely, the Tishomingo area of Johnston County, also on the flank of the East Timbered Hills and the West Timbered Hills of Murray County. In the Wichita Mountains the Reagan outcrops along the hills east of Blue Creek Canyon, Comanche and Caddo counties, and in some outlying hills in T. 6 N., R. 14 W., eastern Kiowa County.

AGE: Upper Cambrian (St. Croixan).

CORRELATION: Hickory sandstone of Texas and possibly a part of the Collier shale of the Ouachitas.

CHARACTERISTIC FOSSILS: (Taff and Decker[1]).

Obolus tetonensis ninus
Acrotreta microscopica
Eorthis wichitaensis
Eorthis remnicha
Ptychoparia roemeri
Ptychoparia affinis
Agraulos convexus

CITATIONS:

Taff, J. A., U. S. Geol. Survey, Atoka folio (No. 79), 1902, Tishomingo folio (No. 98), 1903. Geology of the Arbuckle and Wichita Mountains, etc. U. S. Geol. Survey Prof. Paper 31, 1904.

Gould, C. N., Geology and Water Resources of Oklahoma, U. S. Geol. Survey Water-Supply Paper 148, 1905.

Gould, C. N., Geography of Oklahoma, p. 29, 1909.

Reeds, C. A., Report on the Geology and Mineral Resources of the Arbuckle Mountains, Oklahoma: Okla. Geol. Survey, Bull. 3, p. 32, 1910.

Morgan, Geo. D., Geology of the Stonewall Quadrangle, Okla. Bureau of Geology, Bull. 2, 1924.

1 Unpublished identifications.

ARBUCKLE LIMESTONE

NOMENCLATOR: J. A. Taff, 1902.

TYPE LOCALITY: Arbuckle Mountains, south-central Oklahoma.

CHARACTER: Taff's description from the Tishomingo folio, beginning at the top, follows:

"Medium and thin-bedded limestones 450 feet.

Massive compact magnesian limestone 3,500-4,000 feet. Thin-bedded granular limestone and compact blue limestone 250 feet.

Heavy-bedded, dull-bluish, and cream-colored dolomites 300-400 feet.

Thin-bedded siliceous limestone 50 feet."

THICKNESS: 5,000-6,000 feet.

OCCURRENCE: The Arbuckle limestone makes up the great central mass of the Arbuckle Mountains, occupying considerable portions of southern Pontotoc, northern Johnston, and western Murray counties; outcropping also in eastern Murray and northern Carter counties. In the Wichita Mountains the Arbuckle limestone is exposed as rugged limestone ridges trending parallel to the main axis of the range, dipping northeast, in northern Comanche, southwestern Caddo, and eastern Kiowa counties, and dipping south, in isolated limestone hills northwest of Lawton.

AGE: Fossils in the basil Arbuckle indicate Upper Cambrian age. The upper part of the limestone has been assigned to the Beekmantown (Lower Ordovician).

CORRELATION: May correlate with the upper part of Collier shale, the Crystal Mountain sandstone and the lower part of Mazarn shale. Equivalent to Cap Mountain, Wilberns, and Ellenburger formations of Texas.

CHARACTERISTIC FOSSILS: (Taff, Ulrich, Walcott).

Lower or Cambrian Division

Syntrophia sp.
Dikellocephalus cf. angustifrons (Taff)
Illaenurus sp.?
Dikellocephalus sp.?

Ordovician Division

Cryptozoon proliferum (Alga) (Decker)
Billingsella (2 species)
Maclurea
Ophileta
Eccyliopterus
Euconia cf. ramsyi
Hornotoma cf. artemesia
Trochonema
Orthoceras
Leperditia
Isochilina
Primitia

CITATIONS:

Taff, J. A., U. S. Geol. Survey, Atoka folio (No. 79), 1902, Tishomingo folio (No. 98), 1903. U. S. Geol. Survey, Prof. Paper 31, 1904.
Gould, C. N., U. S. Geol. Survey, Water-Supply Paper 148, p. 27, 1905.
Reeds, C. A., Okla. Geol. Survey, Bull. 3, p. 32, 1910.
Howell, J. V., Notes on the pre-Permian Paleozoics of the Wichita Mountain area; Am. Assoc. Petroleum Geologists, Bull., vol. 6, pp. 413-425, 1922.
Morgan, Geo. D., Bureau of Geology, Bull. 2, 1924.

SIMPSON FORMATION

NOMENCLATOR: J. A. Taff, 1902.

TYPE LOCALITY: Former village of Simpson, 20 miles south of Ada, Pontotoc County.

CHARACTER: Sandstones and thin limestones with interbedded greenish clay, shales, and marls. At or near the base, near the top, and in the central portion there are members of massive sandstone, usually pure white, ranging up to 100 feet thick, which are used for glass sand.

THICKNESS: 200 to 2,000 feet, averaging 1,500 feet.

OCCURRENCE: Near the periphrey of the Arbuckle Mountains, in Pontotoc, Johnston, Murray, and Carter counties. In the Wichitas the Simpson is covered by Permian red beds.

AGE: Middle and Lower Ordovician.

CORRELATION: Probably contains beds that are equivalent to the St. Peter ("Burgen") sandstone, lower part of Stringtown shale, Blakely sandstone, lower part of Womble schistose sandstone, and upper part of Mazarn shale of the Ouachitas.

CHARACTERISTIC FOSSILS: (Taff).

Lower part of Simpson

Orthis costata
Orthis cf. holstoni
Leperditia bivia
Leperditia cf fabulites
Pliomera (Amphion) nevadensis.
Bathyurus sp.?

Upper part of Simpson

Ischadites iowensis
Stomatopora prontana-pertenuis
Phylloporina sublaxa
Rhinidictya nicholosoni
Pholidops trentonensis
Plectambonites sericea
Strophomena filitexta
Orthis tricenaria
Hebertella bellarugosa

CITATIONS:

Taff, J. A., U. S. Geol. Survey, Atoka folio (No. 79), 1902, Tishomingo folio (No. 98), 1903, U. S. Geol. Survey, Prof. Paper 31, 1904.
Reeds, C. A., Okla. Geol. Survey, Bull. 3, p. 34, 1910.
Snider, L. C., Rock Asphalts of Oklahoma; Okla. Geol. Survey, Circular 5, 1913.
Howell, J. V., Am. Assoc. Petroleum Geologists, Bull., vol. 6, pp. 413-425, 1922.
Dake, C. L., The St. Peter Sandstone, Missouri Univ. School of Mines and Metal. Bull., Tech. ser. vol. 6, No. 1, p. 56, 1921.
Edson, Fanny C., Notes on the Simpson Formation of Oklahoma Am. Assoc. Petroleum Geologists, Bull., vol. 7, No. 5, pp. 558-564, 1923.
Morgan, Geo. D., Bureau of Geology, Bull. 2, 1924.

VIOLA LIMESTONE

NOMENCLATOR: J. A. Taff, 1902.

TYPE LOCALITY: Former village of Viola, near Bromide, Johnston County.

CHARACTER: Thin to heavy-bedded massive, homogeneous limestone.

THICKNESS: 500-750 feet.

OCCURRENCE: In the Arbuckle Mountains of Pontotoc, Johnston, Murray, and Carter counties the Viola is typically exposed as a series of bare, rounded limestone knobs, lying outside of the eroded Simpson valley. In the Wichitas three outlying knobs in the vicinity of Rainy Mountain Mission in Kiowa County are referred to the Viola.

AGE: Middle Ordovician (Mohawkian).

CORRELATION: Bigfork chert, upper part of Stringtown shale, lower part of Talihina chert, and lower part of Tyner formation.

CHARACTERISTIC FOSSILS:

Lower part of Viola

Tetradium columnare
Phylloporina reticulata
Rhinidictya mutabilis
Escharopora subrecta
Rhynchotrema increbescens
Vanuxemia gibbosa
Cyrtolites retrorsus
Protowarthia pervoluta
Bumastus trenotonensis

Middle part of Viola

Diplograptus pristis
Climacograptus typicalis
Climacograptus bicornis
Schizotreta minutula
Rafinesquina deltoidea
Cornularia trentonnensis
Trinucleus concentricus
Proetus parviusculus

Upper part of Viola

Pachydicta gigantea
Ptilotrypa obliquata

CITATIONS:

Taff, J. A., U. S. Geol. Survey, Atoka folio (No. 79), 1902, Tishomingo folio (No. 98), 1903. U. S. Geol. Survey, Prof. Paper 31, p. 25, 1904.
Gould, C. N., U. S. Geol. Survey, Water Supply Paper 148, p. 28, 1905.
Reeds, C. A., Okla. Geol. Survey, Bull. 3, 1910.
Howell, J. V., Am. Assoc. Petroleum Geologists, Bull., vol. 6, pp. 413-425, 1922.
Morgan, Geo. D., Bureau of Geology Bull. 2, 1924.

SYLVAN SHALE

NOMENCLATOR: J. A. Taff, 1902.

TYPE LOCALITY: Former village of Sylvan, western Johnston County.

CHARACTER: A greenish or greenish-blue shale, weathering typically into long, narrow valleys.

THICKNESS: 60-300 feet, averaging 150 feet.

OCCURRENCE: In the Arbuckle Mountains of Pontotoc, Johnston, Murray, and Carter counties the Sylvan outcrops outside of the row of rounded hills formed by the Viola limestone.

AGE: Upper Ordovician (Richmond).

CORRELATION: Upper part of Tyner formation.

CHARACTERISTIC FOSSILS: (Taff).

Diplograptus sp.
Climacograptus cf. typicalis
Lingula sp.
Leptobolus sp.
Conularia sp.
Conodonts (several species)
(Numerous tabular crystals of Barite)

CITATIONS:

Taff, J. A., U. S. Geol. Survey, Atoka folio (No. 79), 1902, Tishomingo folio (No. 98), 1903. U. S. Geol. Survey, Prof. Paper 31, p. 28, 1904. U. S. Geol. Survey, Bull. 243, p. 145, 1905.

Reeds, C. A., Okla. Geol. Survey, Bull 3, p. 38, 1910.
Ulrich, E. O., Internat. Geol. Cong. Twelfth Session, Canada, pp. 22-49, 1913.
Morgan, Geo. D., Bureau of Geology, Bull. 2, 1924.

"HUNTON FORMATION"

NOMENCLATOR: J. A. Taff, 1902.

TYPE LOCALITY: Former hamlet of Hunton, southwestern Coal County.

CHARACTER: As originally described by Taff the "Hunton" consists of hard crystalline limestone, thin earthy limestones and marls. His description of the various members follows:

"Upper member—Semicrystalline limestones, in places cherty, interstratified with occasional thin marly layers. Middle member—Marly limestones and calcareous clays, with some hard limestone layers, more abundant in the lower part. Lower member—Thick-bedded crystalline limestone succeeded by hard thin limestone with occasional marly layers. At the base of this limestone is an oolite, 4 to 5 feet thick, which locally is silicified."

Reeds, however, who later studied these rocks, finds that on paleontologic evidence the strata may be divided into four separate formations, and for this reason the term "Hunton" is not now generally used as a formational name. In Morgan's recent work "the term is retained as the name of a terrane in which is included the group of formations which constitute the original unit as defined by Taff."

THICKNESS: 150-300 feet.

OCCURRENCE: The "Hunton" outcrops in the Arbuckle Mountains usually as a narrow, grass-covered ridge, lying between the timbered Sylvan Valley and the jack oak-covered ridge formed by the Woodford chert.

AGE AND CORRELATION: See table page 18.

CORRELATION TABLE OF THE "HUNTON FORMATION," ARBUCKLE MOUNTAINS, OKLAHOMA

By Chester A. Reeds

Period	Series	Stage	Reeds, 1911		Taff, Ulrich and Girty, 1903-1904	
Devonian	Helderbergian	Becraft	Bois d'Arc limestone 0-90 feet, Average 60 feet		UPPER HUNTON	Oriskany
		New Scotland	Haragan shale 0-166 feet, Averages 100 feet			
			.....(Break).....		MIDDLE HUNTON	Helderbergian
	Niagaran	Bob and Lobleville	Henryhouse shale 0-223 feet, average 90 feet.			
			.....(Break).....			
Silurian	Alexandrian	Ohio, Clinton, and Brassfield of Ohio and Kentucky	Chimneyhill limestone 0-53 feet, Average 35 feet	Pink-Crinoid member 9-39 feet, Average 15 feet	LOWER HUNTON	Niagaran
				Glauconitic member 0-25 feet, Average 15 feet		
				Oolitic member, 0-12 feet, Average 5 feet		Clinton

CITATIONS:

Taff, J. A., U. S. Geol. Survey, Atoka folio (No. 79), 1902, Tishomingo folio (No. 98), 1903. U. S. Geol. Survey, Prof. paper 31, p. 29, 1904. U. S. Geol. Survey, Bull. 243, p. 146, 1905.

Reeds, C. A., Okla. Geol. Survey Bull 3, p. 39, 1910. Am. Jour. Sci., 4th ser., vol. 32, pp. 256-268, 1911.

Morgan, Geo. D., Bureau of Geology, Bull. 2, 1924.

CHIMNEYHILL LIMESTONE

NOMENCLATOR: C. A. Reeds, 1911.

TYPE LOCALITY: Chimneyhill, at the confluence of three small creeks, sec. 4, T. 2 N., R. 6 E., Johnston County.

CHARACTER: The Chimneyhill consists of a lower oolitic member, averaging 5 feet thick; a middle glauconitic member, averaging 15 feet thick; and an upper crinoidal member, averaging 15 feet thick.

THICKNESS: The average thickness is 35 feet.

OCCURRENCE: See under "Hunton."

AGE: The Chimneyhill is of early Silurian age, containing Brassfield fossils.

CORRELATION: Medina of New York and Blaylock sandstone of southeastern Oklahoma.

CHARACTERISTIC FOSSILS: (Reeds).

Oolitic member

Atrypa sp.
Cyclonema daytonensis.

Glauconitic member

Pachydicta bifurcata
Phenopora fimbriata
Phenopora magna
Rhinopora verrucosa
Plectambonites transversalis
Cyclonema ventricosa
Illaenus ambiguas

Pink-crinoidal member

Pisocrinus sp.
Plectambonites tennesseensis
Spirifer radiatus
Stropheodonta corrugata
Dalmanites arkansus
Odontopleura arkansana

All three members

Dalmanella elegantula
Hebertella fausta
Platystrophia biforata

CITATIONS:

Reeds, C. A., Am., Jour. Sci., 4th ser., vol. 32, p. 258, 1911. Geol. Soc. Am., Bull., vol. 25, p. 75, 1914.
Morgan, Geo. D., Bureau of Geology, Bull. 2, 1924.

HENRYHOUSE SHALE

NOMENCLATOR: C. A. Reeds, 1911.

TYPE LOCALITY: Henryhouse Creek, south slope of Arbuckle Mountains, northern Carter County.

CHARACTER: Grayish to drab-colored shales and soft marly limestone.

THICKNESS: 0-223 feet; average 90 feet.

OCCURRENCE: See under "Hunton."

AGE: The Henryhouse is believed to be of Niagaran age.

CORRELATION: Middle part of Talihina chert, St. Clair marble, and Missouri Mountain slate.

CHARACTERISTIC FOSSILS: (Reeds).

Lower Henryhouse

Scenidium insigne,
Strophonella prolongata,
Ceraurus niagarensis.

Upper Henryhouse

Astylospongia praemorsa
Aulopora repens
Eridophyllum rugosum
Favosites niagarensis
Favosites venustus
Plasmopora folis
Heliolites interstinctus
Pisocrinus milliganae
Synbathocrinus tennesseensis
Rhychonella crispus
Strophonella tenuistriata
Cyrtoceras subrectum

Lower and Upper Henryhouse

Fistulipora hemispherica
Pachydictya crassa
Bilobites saffordi
Dictyonella gibbosa
Spirifer saffordi
Calymene cf. camerata

CITATIONS:

Reeds, C. A., Am. Jour. Sci., 4th ser., vol. 32, p. 261, 1911.
Morgan, Geo. D., Bureau of Geology, Bull. 2, 1924.

HARAGAN SHALE

NOMENCLATOR: C. A. Reeds, 1911.

TYPE LOCALITY: Haragan Creek and farmhouse, sec. 17, T. 2 S., R. 3 E., 3 miles southeast of Dougherty, Murray County.

CHARACTER: Soft marly shale, gray to drab color, with interbedded marly limestone.

THICKNESS: 0-166 feet; average 100 feet.

OCCURRENCE: See under "Hunton."

AGE: Helderbergian (Lower Devonian).

CHARACTERISTIC FOSSILS: (Reeds).

Favosites conicus
Stiatopora issa
Scyphocrinus (Camarocrinus) ulrichi
Callopora perelegans
Fistulipora maculosa
Atrypina imbricata
Camarotoechia bialveata
Dalmanella subcarinita
Orthostrophia strophomenoides
Meristella arcuata
Stropheodonta varistriata
Diaphorostoma ventricosa
Platyceras gebhardi
Tentaculites gyracanthus
Phacops logani
Dicranurus hamatus

CITATIONS:

Reeds, C. A., Am. Jour. Sci., 4th ser., vol. 32, p. 263, 1911.
Morgan, Geo. D., Bureau of Geology, Bull. 2, 1924.

BOIS D'ARC LIMESTONE

NOMENCLATOR: C. A. Reeds, 1911.

TYPE LOCALITY: Bois d'Arc Creek, sec. 4, T. 2 N., R. 6 E., Pontotoc County.

CHARACTER: White to gray crystalline limestone with thin beds of chert. Usually outcrops as conspicuous hogback ridges.

THICKNESS: 0-90 feet; average 60 feet.

OCCURRENCE: See under "Hunton."

AGE: The Bois d'Arc limestone is of Oriskany (middle and lower) Devonian age.

CORRELATION: Lower part of Arkansas novaculite and a part of the Talihina chert.

CHARACTERISTIC FOSSILS: (Reeds).

Favosites shriveri
Cyrtina rostrata
Eatonia singularis
Leptostrophia magnifica
Merestella laevis
Rensselaeria marylandica
Spirifer concinna
Stropheodonta becki
Strophonella cavumbona
Platyceras cf. tenuiliratum

CITATIONS:

Reeds, C. A., Am. Jour. Sci., 4th ser., vol. 32, p. 264, 1911.

Schuchert, Chas., Geol. Soc. Am. Bull., vol. 33, p. 667, 1922.
Morgan, Geo. D., Bureau of Geology, Bull. 2, 1924.

WOODFORD CHERT

NOMENCLATOR: J. A. Taff, 1902.

TYPE LOCALITY: Village of Woodford, Carter County.

CHARACTER: Limy chert and shales.

THICKNESS: The average thickness of the Woodford is about 625 feet.

OCCURRENCE: The Woodford occurs around the periphery of the Arbuckle Mountains, being exposed in Pontotoc, Murray, Johnston, and Carter counties. The outcrop usually forms rough lowlands covered with jack oak timber.

AGE AND CORRELATION: The Woodford has usually been considered Upper Devonian. It correlates with the Chattanooga shale of Oklahoma, Arkansas, and Tennessee, and since the age of this shale is in question, being assigned by some geologists to the Carboniferous and by others to the Devonian, the Woodford is here doubtfully assigned to the Devonian. According to Miser, beds of the same age and lithology as the Woodford are present in the top of the Talihina chert and the Arkansas novaculite.

CHARACTERISTIC FOSSILS: (Morgan).

Lingula cf. spatulata
Batesviliae
Leptaena rhomboidalis,
Productella cf. concentrica
hirsutiformis,
Liorhynchus carboniferum
Spirifer moorefieldanus
Spirifer sp.
Dadoxylon (a plant)

CITATIONS:

Taff, J. A., U. S. Geol. Survey, Atoka folio (No. 79), 1902, Tishomingo folio (No. 98), 1903. U. S. Geol. Survey, Prof. Paper 31, p. 31, 1904.
Girty, G. H., U. S. Geol. Survey, Bull. 377, pp. 6, 40, 1909.
Reeds, C. A., Okla. Geol. Survey, Bull. 3, p. 40, 1910.
Morgan, Geo. D., Bureau of Geology, Bull. 2, 1924.

SYCAMORE LIMESTONE

NOMENCLATOR: J. A. Taff, 1903.

TYPE LOCALITY: Sycamore Creek, western Johnston County.

CHARACTER: Rather hard, tough-slaty, blue limestone,

weathering yellow. Often separated into thin beds, usually a foot or two in thickness.

THICKNESS: Variable up to 200 feet.

OCCURRENCE: In the Arbuckle Mountains, outside the Woodford chert ridge.

AGE AND CORRELATION: The age of the Sycamore has been a matter of controversy, and it is altogether possible that the last word on the subject has not yet been written. Morgan concludes that the Sycamore, together with the upper portion of the Woodford and the lower portion of the Caney, is partly equivalent to the Moorefield shale of northern Arkansas. This correlation would place it in the upper Mississippian. Following the preponderence of opinion, however, the Sycamore is here assigned to the basal part of the Mississippian and correlated with the Boone limestone.

CHARACTERISTIC FOSSILS: (Morgan and Cooper).

Menophyllum sp.
Ambocoelia levicula
Productella n. sp.
Chonetes geniculatus
Brachythyris peculiaris
Composita buckleyi
Proetus sp.
Ostracoda

CITATIONS:

Taff, J. A., U. S. Geol. Survey, Tishomingo folio (No. 98), 1903. U. S. Geol. Survey, Prof. Paper 31, p. 33, 1904.
Reeds, C. A., Okla. Geol. Survey, Bull. 3, p. 41, 1910.
Morgan, Geo. D., Bureau of Geology, Bull. 2, 1924.

CANEY SHALE

NOMENCLATOR: J. A. Taff, 1901.

TYPE LOCALITY: Cane Creek, northwest Pushmataha County. Under date of February 24, 1925, Mr. Taff sent the writer the following:

"I had gotten into my mind that the type locality of this shale had been described. From time to time since getting your letter I have been searching for the description but have not found it. The locality is the valley of Cane Creek in the center of the Tuskahoma syncline at the south line of the McAlester quadrangle, also on the line between T. 1 N., and T. 1 S., R. 16 E., now Pushmataha County. The discovery was made in 1897 while surveying the McAlester quadrangle. The following season Dr. Girty and I made extensive collections of Carboniferous fossils from concretions in the Caney shale, and Ordovician fossils from associated erratic limestone boulders in the same shale. At that time the McAlester sheet had not been drawn and we were using the topographer's plane-table sheets. The stream having its source in this mountain valley was recorded as Caney Creek, but apparently when the

map was engraved, and after the Board on Geographic Names had passed upon the names to be used, in view of the fact that other streams in the Indian Territory had received the name Caney, this particular one was given the name Cane, instead of Caney. Morgan's inference, as you state, that Caney town in Atoka County is the type locality, is wide of the mark. Our original Caney Creek which cut across and exposes the Caney shale and where the very fossiliferous beds near the base are well exposed is the type locality, while the Caney town in Atoka County is located on the Cretaceous and far removed from any Caney shale exposures.

"The only reference in the literature to the Caney shale at the type locality is in Bulletin No. 377. The Fauna of the Caney Shale of Oklahoma, by Geo. H. Girty, where fossil localities are described as occurring in sections 3 and 4, T. 1 S., R. 16 E., on pages 74 and 75. For some reason Dr. Girty fails to record the collections we made here in 1898 prior to any publications recording the Caney shale which began with the Coalgate folio in 1901.

"The failure to describe the type locality of the Caney shale seems to be due to the fact that the publications began in the Coalgate folio which did not include the type locality and the characteristics of the folio texts which in the earlier stages in particular excluded detailed descriptions."

CHARACTER: Lower part, black shales and slates with limestone lentils; upper part, lighter colored blue and greenish-blue shales with sandy members.

THICKNESS: 800-1,600 feet.

OCCURRENCE: The Caney is exposed around the margin of the Arbuckle Mountains in Pontotoc, Coal, Johnston, Murray, and Carter counties. Also in numerous localities in Atoka, Pushmataha, Pittsburg, Latimer, and LeFlore counties, and in the Ouachita Mountains, particularly along the northern margin of this group.

AGE AND CORRELATION: There has been considerable controversy regarding the age of the Caney shale, but the present consensus of opinion seems to be that the upper part of the formation is of Pennsylvanian age, approximately the equivalent of the lower part of the Morrow formation, and that the lower part is of Mississippian age, and equivalent to the Moorefield, Batesville, Fayetteville, and Pitkin formations of Arkansas and eastern Oklahoma. It is also correlated with the Barnett shale of north-central Texas.[1]

1 Morgan's conclusion is as follows: "After completing a study of the Caney and Wapanucka faunas it appears that it would be desirable to restrict the term Caney to the Mississippian part of the formation and to describe as a new formation the upper or Pennsylvanian part. Time, however, is not available to make the necessary changes in mapping so that this undertaking will have to be left to the future."

CHARACTERISTIC FOSSILS: (Girty and Morgan).

Lingula albapinensis
Lingula paracletus
Lingulidiscina newberryi caneyana
Chonetes planumbonus var. choctawensis
Productella hirsutiformis
Liorynchus carboniferum
Caneyella nasuta
Caneyella vaughani
Orthoceras caneyanum
Actinoceras vaughanianum

CITATIONS:

Taff, J. A., U. S. Geol. Survey, Coalgate folio (No. 74), 1901, Atoka folio (No. 79), 1902, Tishomingo folio (No. 98), 1903. U. S. Geol. Survey, Prof. Paper 31, p. 33, 1904. U. S. Geol. Survey, Bull. 380, p. 289, 1909. Science, new ser., vol. 29, p. 637, 1909. Geol. Soc. Am., Bull., vol. 20, pp. 701-702, 1910.

Girty, G. H., U. S. Geol. Survey, Bull. 377, 1909.

Reeds, C. A., Okla. Geol. Survey, Bull. 3, p. 42, 1910.

Woodworth, J. B., Geol. Soc. Am., Bull., vol. 23, pp. 457-462, 1912.

Miser, H. D., Am. Jour. Sci., 5th ser., vol. 2, p. 65, 1921.

Goldston, W. L., Jr., Am. Assoc. Petroleum Geologists, Bull., vol. 6, p. 7, 1922.

Morgan, Geo. D., Bureau of Geology, Bull. 2, pp. 50-56, 1924.

GLENN FORMATION

NOMENCLATOR: J. A. Taff, 1903.

TYPE LOCALITY: Town of Glenn, northern Carter County.

CHARACTER: According to Taff's original description in the Tishomingo folio, the Glenn is composed chiefly of friable, bluish clay shales, and thin beds of brown, or drab, sandstone with thin argillaceous limestone strata and limestone conglomerates.

THICKNESS: According to Goldston about 15,000 to 19,000 feet.

OCCURRENCE: The Glenn is exposed only south of the Arbuckle Mountains, in southwestern Johnston and northern Carter counties and extends across east-central Carter into northern Love County.

AGE AND CORRELATION: Goldston has divided the Glenn formation into five members as follows, beginning at the bottom:

Springer Member. Four thousand to 6,000 feet thick, cossisting of black and blue shales separated by thin beds of sandstone and limestone.

Otterville Limestone Member. 70 feet thick, solid brown limestone.

Cup Coral Member. 1,500 to 1,800 feet thick, chiefly blue shales and thin sandstones.

Deese Member. 6,000 to 8,000 feet thick containing massive sandstones, conglomerates, shales and limestones.

Hoxbar Member. 4,000 feet thick, brown lime, white sandstone, light blue to yellow and red shales with a bed of coal two to four feet thick.

On the basis of fossils these various members have been correlated by Golston with the Pennsylvania formations of north-central Texas and Oklahoma north of the Arbuckle Mountains.

CORRELATION TABLE OF W. L. GOLDSTON, JR.[1]

North Central Texas	Oklahoma South of Arbuckle Mountains	Oklahoma North of Arbuckle Mountains
Canyon formation	GLENN FORMATION Hoxbar member	Holdenville shale Wewoka formation Wetumka shale Calvin sandstone
Strawn formation	Deese member	Sonora formation Stuart shale Thurman sandstone
Millsap formation	Cup Coral member Otterville limestone	Boggy shale Savanna sandstone McAlester shale
Smithwick shales Marble Falls limestone	Springer member	Hartshorne sandstone Atoka formation Wapanucka limestone
Lower Bend shale	Caney shale	Caney shale

Characteristic Fossils:

Springer Member (Waters)

Agassizocrinus conicus
Archimedes cf. owenanus
Septopora biserialis
Chonetes verneuilianus mesolobus
Spirifer cameratus
Leda bellistriata
Nucula ventricosa
Astartella concentrica
Bucanopsis meekana

[1] The Glenn as mapped on the State map corresponds to the Glenn formation of W. L. Goldston, Jr., except that his Springer member of the formation, north of Ardmore is included in the Caney shale. His Springer member around the Criner Hills south of Ardmore is held by George H. Girty and P. V. Roundy to be younger than the Springer north of Ardmore, and is mapped as a part of the Glenn.

The faunas from the Glenn as represented on the State map show, according to G. H. Girty, that it correlates with all of the formations from the Wapanucka limestone up to perhaps the base of the Seminole conglomerate or up to even higher beds.—H. D. Miser.

Derbya crassa
Productus insinuatus
Trachydomia wheeleri
Naticopsis altonensis

Otterville Limestone Member (Girty and Roundy)

Fenestella tenax
Prismopora concava
Pustula symmetrica
Marginifera muricata
Hustedia brentwoodensis
Parallelodon obsoletum
Euphemus carbonarius
Schizostoma catilloides
Meekospira peracuta
Griffithides sp.

Cup Coral Member (Girty, Roundy, and Swiger)

Fusulina secalica
Campophyllum torquium
Lophophyllum profundum
Syringopora multattenuata
Fistulipora carbonaria
Marginifera wabashensis
Cliothyridina orbicularis
Productus longispinus
Productus semireticulatus
Spirifer cameratus
Spirifer rockymontanus
Productus coloradoensis
Parallelodon tenuistriatum
Allorisma terminale
Platyceras occidentale
Paralegoceras iowense

Deese Member (Girty and Roundy)

Axophyllum rude
Spirifer rockymontanus
Cliothyridina orbicularis
Leda bellistriata
Nucula anadontoides
Dentalium semicostatum
Meekospira peracuta
Pseudorthoceras knoxense

Hoxbar Member (Girty and Roundy)

Fusulina sp.,
Spirifer triplicatus,
Squamularia perplexa,
Composita subtilita.

Citations:

Taff, J. A., U. S. Geol. Survey, Tishomingo folio (No. 98), 1903. U. S. Geol. Survey, Prof. Paper 31, p. 50, 1904.

Goldston, W. L., Jr., Am. Assoc. Petroleum Geologists, Bull., vol. 6, pp. 5-23, 1922.

Girty, G. H., and Roundy, P. V., Am. Assoc. Petroleum Geologists, Bull., vol. 7, pp. 331-349, 1923.

Bullard, Fred M., Okla. Geol. Survey, Bull. 33, pp. 14-15, 1925.

OUACHITA MOUNTAIN SECTION AND CARBONIFEROUS OF SOUTHEASTERN OKLAHOMA

COLLIER SHALE

NOMENCLATOR: A. H. Purdue, 1909.

TYPE LOCALITY: Collier Creek, Montgomery County, Arkansas.

CHARACTER: Graphitic, unctuous shales carrying boulder beds in the upper part and capped by 30 feet of thin-bedded replacement limestones. Large quartz-orthoclase pegmatites occur, which are regarded by Honess "as having had an igneous source."

THICKNESS: 200 feet plus; base not exposed.

OCCURRENCE: The Collier is exposed in central McCurtain County, on the upper waters of Lukfata and Yashoo creeks and along Mountain Fork near Hochatown.

AGE AND CORRELATION: The Collier shale is believed to be Cambrian in age, and is correlated with the Reagan sandstone and basal part of the Arbuckle limestone. It may be the time equivalent of a part or of all of the Hickory, Cap Mountain, Wilberns, and Ellenburger formations of Texas.

CHARACTERISTIC FOSSIL: (Honess).

Siliceous algae sp.

CITATIONS:

Purdue, A. H., Slates of Arkansas: Ark. Geol. Survey, p. 31, 1909.
Ulrich, E. O., Geol. Soc. Am., Bull., vol. 22, p. 676, 1911.
Miser, H. D., U. S. Geol. Survey, Bull. 660, p. 68, 1917.
Honess, C. W., Geology of the Southern Ouachita Mountains of Oklahoma: Okla. Geol. Survey, Bull. 32, pp. 33-45, 1923.

CRYSTAL MOUNTAIN SANDSTONE

NOMENCLATOR: A. H. Purdue, 1909.

TYPE LOCALITY: Crystal Mountains, Montgomery and Garland counties, Arkansas.

CHARACTER: Uniform, medium-grained, massive, gray sandstone, portions of which are veritable quartzites; other parts are partly replaced by an abundant carbonate; these upon weathering become porous and ferruginous. A 14-foot basal con-

glomerate occurs to the westward at the base of the formation, carrying boulders of chert and limestone up to 8 inches in diameter. Numerous large and small quartz-orthoclase pegmatites probably of igneous origin, occur throughout.

THICKNESS: 500 feet +−.

OCCURRENCE: Central McCurtain County along the head waters of Lukfata and Yashoo creeks.

AGE: The Crystal Mountain sandstone is probably of Lower Ordovician age. It has not yielded any fossils.

CITATIONS:

Purdue, A. H., Slates of Arkansas: Ark. Geol. Survey, p. 32, 1909.
Ulrich, E. O., Geol. Soc. Am., Bull., vol. 22, p. 676, 1911.
Miser, H. D., U. S. Geol. Survey, Bull. 660, p. 68, 1917.
Honess, C. W., Okla. Geol. Survey, Bull. 32, pp. 46-55, 1923.

MAZARN SHALE

(The Mazarn shale, and two succeeding formations, Blakely sandstone and Womble shale, were originally described by Purdue under the name "Ouachita shale.")

NOMENCLATOR: H. D. Miser, 1917.

TYPE LOCALITY: Marzarn Creek, eastern Montgomery County, Arkansas.

CHARACTER: Dark-colored, carbonaceous, hard, clay shale and slates penetrated by a few veins of kaolinite and quartz.

THICKNESS: 1,000 feet +−.

OCCURRENCE: Along Glover Creek in T. 5 S., R. 23 E., central McCurtain County.

AGE: Lower Ordovician (Beekmantown).

CORRELATION: Possibly correlates with the upper part of Arbuckle limestone and lower part of Simpson formation.

CITATIONS:

Miser, H. D., U. S. Geol. Survey, Bull. 660, p. 68, 1917.
Honess, C. W., Okla. Geol. Survey, Bull. 32, pp. 55-58, 1923.

BLAKELY SANDSTONE

NOMENCLATORS: A. H. Purdue and E. O. Ulrich, 1911, and H. D. Miser, 1917.

TYPE LOCALITY: Blakely Mountain, Garland County, Arkansas.

CHARACTER: Dark, smoky-gray quartzite, cut by "penetration veins" of smoky quartz.

THICKNESS: 0-15 feet.

OCCURRENCE: Two small areas in T. 5 S., R. 23 E., central McCurtain County.

AGE: Lower Ordovician (Beekmantown and possibly early Chazy).

CORRELATION: Probably correlates with part of St. Peter sandstone, lower part of Stringtown shale, and a portion of Simpson formation.

CITATIONS:

Ulrich, E. O., Geol. Soc. Am., Bull., vol. 22, p. 676, 1911.
Miser, H. D., U. S. Geol. Survey, Bull. 660, p. 67, 1917.
Purdue, A. H., and Miser, H. D., U. S. Geol. Survey, Geol. Atlas Hot Springs folio (No. 215), 1923.
Honess, C. W., Okla. Geol. Survey, Bull. 32, pp. 58-62, 1923.

WOMBLE SCHISTOSE SANDSTONE

NOMENCLATOR: H. D. Miser, 1917.

TYPE LOCALITY: Town of Womble, central Montgomery County, Arkansas.

CHARACTER: Schistose, micaceous, fine-grained sandstones and grits, green in color when fresh, weathering red, interbedded with which are a few shales. Massive, spongy, brown sandstone appears at the top.[1]

THICKNESS: 1,000 feet.

OCCURRENCE: Along Glover and Mountain Fork Creeks and intervening territory in central McCurtain County.

[1]Honess describes a diorite sill intruded into the Womble Schistose sandstone about 4 miles north of the village of Glover, in sections 10 and 13, T. 5 S., A. 23 E. The extreme observed thickness is 10 feet, and the outcrop has been traced for a half a mile. It is described as a dense, tough, hard rock of greenish-gray color. "It contains very little alkalic feldspar and no quartz and should probably be called a quartz-free diorite."

AGE: Lower Ordovician (probably late Chazy).

CORRELATION: Upper part of Simpson formation and upper part of Stringtown shale.

CITATIONS:

Miser, H. D., U. S. Geol. Survey, Bull. 660, p. 67, 1917.
Purdue, A. H., and Miser, H. D., U. S. Geol. Survey, Hot Springs folio (No. 215), 1923.
Honess, C. W., Okla. Geol. Survey, Bull. 32, pp. 62-70, 1923.

BIGFORK CHERT

NOMENCLATOR: A. H. Purdue, 1909.

TYPE LOCALITY: Big Fork Postoffice, Polk County, Arkansas.

CHARACTER: Hard, black chert, in beds 4 inches to 2 feet in thickness, interbedded with which are some coal-black shales and a number of heavy ledges of black, cherty, fossiliferous limestone.

THICKNESS: 500 feet plus.

OCCURRENCE: Along Mountain Fork and Glover creeks and their tributaries in central McCurtain County.

AGE: Middle Ordovician.

CORRELATION: Viola limestone, probably middle part of Tyner formation, and lower part of the Talihina chert.

CITATIONS:

Purdue, A. H., Slates of Arkansas: Ark. Geol. Survey, p. 35, 1909.
Purdue, A. H., and Miser, H. D., U. S. Geol. Survey, Hot Springs folio (No. 215), 1923.
Honess, C. W., Okla. Geol. Survey, Bull. 32, pp. 70-80, 1923.

POLK CREEK SHALE

NOMENCLATOR: A. H. Purdue, 1909.

TYPE LOCALITY: Polk Creek, Montgomery County, Arkansas.

CHARACTER: Coal-black, graphitic, soft slate and shale carrying an abundance of undeterminable graptolites.

THICKNESS: 100 feet +—.

OCCURRENCE: Along Glover Creek and Mountain Fork and their tributaries in central McCurtain County.

AGE: Upper (?) Ordovician.

CORRELATION: Represents much of middle part of Talihina chert.

CHARACTERISTIC FOSSIL: (Honess).

Graptolites (unidentifiable)

CITATIONS:

Purdue, A. H., Slates of Arkansas: Ark. Geol. Survey, p. 39, 1909.
Ulrich, E. O., Internat. Geol. Cong., Twelfth Session, Canada, p. 22, 1913.
Purdue, A. H., and Miser, H. D., U. S. Geol. Survey, Hot Springs folio (No. 215), 1923.
Honess, C. W., Okla. Geol. Survey, Bull. 32, pp. 81-87, 1923.

BLAYLOCK SANDSTONE

NOMENCLATOR: A. H. Purdue, 1909.

TYPE LOCALITY: Blaylock Mountain, Montgomery County, Arkansas.

CHARACTER: Thin-bedded, fine-grained, greenish-gray, hard sandstones and interbedded shaly sandstones, and dark shales weathering red. Thin veins of smoky quartz are common.

THICKNESS: 800 feet.

OCCURRENCE: Along Mountain Fork and its tributaries and Glover Creek in central McCurtain County.

AGE: Early Silurian (Medina).

CORRELATION: Brassfield limestone of Ohio and Chimney-hill limestone of Oklahoma. The Blaylock sandstone is also represented in the Talihina chert, either by a time break or by rocks of different lithology.

CHARACTERISTIC FOSSILS: (Honess and Ulrich).

E. O. Ulrich has identified seven species of graptolites as forms belonging to the Birkhill shales (Silurian of Scotland); numerous worm trails.

CITATIONS:

Purdue, A. H., Slates of Arkansas: Ark. Geol. Survey, p. 36, 1909.
Ulrich, E. O., Intern. Cong., Twelfth Session, Canada, p. 23, 1913.

Purdue, A. H., and Miser, H. D., Hot Springs folio (No. 215), 1923.
Honess, C. W., Okla. Geol. Survey, Bull. 32, pp. 87-104, 1923.

MISSOURI MOUNTAIN SLATE

NOMENCLATOR: A. H. Purdue, 1909.

TYPE LOCALITY: Missouri Mountains, Polk and Montgomery counties, Arkansas.

CHARACTER: Red and green metamorphosed shale and slate with carbonated pyroclastic material near the top.

THICKNESS: 70-100 feet.

OCCURRENCE: In eastern McCurtain County, usually concealed under a cover of Arkansas novaculite float or appearing in small isolated exposures.

AGE: Probably Silurian.

CORRELATION: Equivalent to much of the middle part of Talihina chert.

CITATIONS:

Purdue, A. H., Slates of Arkansas: Ark. Geol. Survey, p. 37, 1909.
Honess, C. W., Okla. Geol. Survey, Bull. 32, pp. 104-109, 1923.

ARKANSAS NOVACULITE

NOMENCLATOR: A. H. Purdue, 1909.

TYPE LOCALITY: Purdue says: "The Arkansas novaculite is the principal formation of the Ouachita range." The name is from the State.

CHARACTER: Heavy-bedded, white novaculite forms the lower third of the formation; thin-bedded black novaculite and interbedded black slates and shales form the middle portion; and a white novaculite, 20-100 feet thick, forms the top. The top part of the formations contains a considerable quantity of manganese-bearing carbonate. A 4-inch bed of agglomerate occurs locally to the east at the top of the basal division, and lenses or pockets of psilomelane and the manganese minerals occur in two definite horizons in the basal division. In the SW¼ sec. 29, T. 5 S., R. 22 E., ashy tuffs occur.

THICKNESS: 250-540 feet.

OCCURRENCE: Honess says: "The Arkansas novaculite comes to the surface in a long line of narrow exposures woven together in a tightly compressed series of V's, M's and W's due to the highly tilted and folded conditions of the beds." The formation outcrops chiefly along Mountain Fork in central and northeastern McCurtain County.

AGE: Devonian.

CORRELATION: Lower third probably correlates with Bois d'Arc limestone and upper two-thirds correlate with Woodford chert and Chattanooga shale. The Arkansas novaculite represents the upper part of Talihina chert.

CHARACTERISTIC FOSSILS: (Miser and Honess).

Leptocoelia flabellites, Conodonts and Fucoids

CITATIONS:

Purdue, A. H. Slates of Arkansas: Ark. Geol. Survey, p 39, 1909.
Miser, H. D., U. S. Geol. Survey, Bull. 660, p. 66, 1917.
Honess, C. W., Okla. Geol. Survey, Bull. 32, pp. 109-137, 1923.

STRINGTOWN SHALE[1]

NOMENCLATOR: J. A. Taff, 1902.

TYPE LOCALITY: Stringtown, Atoka County.

CHARACTER: Black and blue shales with a bed of cherty shale.

THICKNESS: 600 feet plus.

OCCURRENCE: As a narrow band paralleling the Choctaw fault from Springtown to Atoka. Also in Round Prairie, in the Potato Hills west of Talihina, in southern Latimer and northern Pushmataha counties.

AGE: Lower Ordovician.

CORRELATION: Upper part of Simpson formation, Womble, and Blakely sandstones, and St. Peter ("Burgen") sandstone.

[1] The Stringtown and the next succeeding formation, the Talihina chert, are exposed in several places in the western part of the Ouachitas, but the largest exposures are near Atoka and in the Potato Hills west of Talihina. To the equivalent beds in McCurtain County several formation names have been applied.

CITATION:

Taff, J. A., U. S. Geol. Survey, Atoka folio (No. 79), p. 4, 1902.

TALIHINA CHERT

NOMENCLATOR: J. A. Taff, 1902.

TYPE LOCALITY: Talihina, southern LeFlore County.

CHARACTER: Top: Blue, greenish, and white stratified flint and chert; middle: cherty and clay shales; bottom: black, bluish and white flint chert and cherty shale with thin lentils of blue limestone.

THICKNESS: 1,150 feet.

OCCURRENCE: Black Knob Ridge east and northeast of Atoka; the Potato Hills southwest of Talihina in northern Pushmatah and southern Latimer counties; and a few localities between Atoka and the Potato Hills.

AGE: The Talihina is composed of beds of Ordovician, Silurian, and Devonian age.

CORRELATION: Viola limestone, "Hunton formation," and Woodford chert of the Arbuckle section. According to Miser, "the Talihina is composed of four distinct parts, which correspond in lithology and age to the Arkansas novaculite, Missouri Mountain slate, Polk Creek shale, and Bigfork chert. The Blaylock sandstone is apparently not represented by beds in Talihina chert."

CITATION:

Taff, J. A., U. S. Geol. Survey, Atoka folio (No. 79), p. 4, 1904.

STANLEY SHALE

NOMENCLATOR: J. A. Taff, 1902.

TYPE LOCALITY: Town of Stanley, Pushmataha County.

CHARACTER: Thin-bedded, ripple-marked, fine-grained, dark-colored, hard sandstones, and blue clay shales and slates irregularly interbedded in one vast series. A bed of tuff 100 feet thick occurs near the bottom; a layer of cone-in-cone concretions appears in the middle, and a bed of black chert, 25 feet thick, in the upper middle portion.

THICKNES: 6,000 feet +—.

OCCURRENCE: Exposed throughout the greater part of the Ouachita Mountains in northern McCurtain, northern Pushmataha, eastern Atoka, southern Pittsburg, southern Latimer, and southern LeFlore counties.

AGE: There has been considerable difference of opinion regarding the age of the Stanley. On account of meager fossil evidence it is not possible at this date to write the final word on the matter. However, in the light of present available information it appears altogether possible that when all data are in, the Stanley will finally be determined as upper Mississippian in age.

CHARACTERISTIC FOSSILS: (Honess, Schuchert).

Orbiculoidea nitida
Cystodictya sp.
Rhombopora sp.
Fenestella sp.
Chonetes sp.
Productus sp.

CITATIONS:

Taff, J. A., U. S. Geol. Survey, Atoka folio (No. 79), p. 4, 1902. U. S. Gelo. Survey, Bull. 380, p. 289, 1909.
Honess, C. W., Am. Jour. Sci., 5th ser., vol. 1, pp. 63-80, 1921.
Miser, H. D., Am. Jour. Sci., 5th ser., vol. 2, pp. 65-69, 1921.
Honess, C. W., Okla. Geol. Survey, Bull. 32, pp. 137-202, 1923; Bureau of Geology, Circular 3, pp. 6-9, 1924.

JACKFORK FORMATION

NOMENCLATOR: J. A. Taff, 1902.

TYPE LOCALITY: Jackfork Mountain, southeastern Pittsburg County.

CHARACTER: Heavy-bedded, massive, medium to fine-grained, gray sandstones with dark shales at wide intervals.

THICKNESS: 3,800 feet +—.

OCCURRENCE: The Jackfork is the mountain-making range of the Ouachita Mountains and is widely exposed in Pushamataha, eastern Atoka, southeastern Pittsburg, southern Latimer, southern LeFlore, and northern McCurtain counties.

AGE AND CORRELATION: There has been much controversy on the age of the Jackfork. A Morrow (lower Pennsylvanian)

fauna has been found by Honess at the base of his "Upper Jackfork" sandstone, which he correlates with the Atoka formation. Miser, therefore, excludes the "Upper Jackfork" of Honess from the Jackfork formation and maps it as Atoka on the State map. The true Jackfork sandstone is classified as of Mississippian age by the United States Geological Survey.[1]

CHARACTERISTIC FOSSILS: (Honess).

Zaphrentis gibsoni
Aulopora magna
Rhipidomella pecosi
Chonetes arkansanus
Spiriferina spinosa
Nucula parva
Schizodus wheeleri
Conocardium parrishi
Phanerotrema grayvillense
Euphemus carbonarius
Orestes nodosus
Platyceras parvum
Sphaerodoma primigenia
Conularia crustula
Metacoceras cornutum
Gastriocerus excelsum

CITATIONS:

Taff, J. A., U. S. Geol. Survey, Atoka folio (No. 79), 1902. U. S. Geol. Survey, Bull. 380, p. 289, 1909.
Miser, H. D., Am. Jour. Sci., 5th ser., vol. 2, pp. 65-69, 1921.
Honess, C. W., Okla. Geol. Survey, Bull. 32, p. 202, 1923. Bureau of Geology, Circular 3, 1924.

CANEY SHALE

For description of Caney shale see page 23.

WAPANUCKA LIMESTONE

NOMENCLATOR: J. A. Taff, 1901.

TYPE LOCALITY: Town of Wapanucka, Johnston County.

CHARACTER: Massive white to light-brown limestone, white chert, sandstone and shale, sometimes oolitic, becoming sandy eastward.

1 Explanation: Honess and I went together in 1923, to his main fossil locality in his Jackfork sandstone. He correlates, in his report, the fossil-bearing beds with the Wapanucka and Morrow formations. The sandstone that overlies the fossil-bearing horizon is called by him Upper Jackfork and the sandstone below is called by him Lower Jackfork. Although he correlates his Upper Jackfork with the Atoka he calls it Jackfork, because it looks not like the Atoka but like the real Jackfork. If we, in applying formation names, are to follow time equivalency instead of lithologic character, the Upper Jackfork of Honess should, in my opinion, be called Atoka. I have so called it and shown it on the State map. Taff says that he believes Honess' Jackfork fauna is not from real Jackfork but from Atoka.—H. D. Miser.

THICKNESS: Average 300 feet.

OCCURRENCE: Outcropping from the northeast flank of the Arbuckle Mountains in Coal, Johnston, and Atoka counties. Also as a long, narrow ridge, sometimes repeated by faulting, paralleling the north flank of the Ouachita Mountains in Atoka, Pittsburg, and Latimer counties.

AGE: Lower Pennsylvanian.

CORRELATION: Upper part of Morrow formation of northeast Oklahoma, a part of the Glenn formation, and the Marble Falls limestone of Texas.

CHARACTERISTIC FOSSILS: (Taff, Morgan, Girty, Roundy).

Michelinia eugeneae
Pentremites angustus
Glyptopora crassistoma
Spirifer rockymontanus
Hustedia mormoni
Hustedia brentwoodensis
Composita subtilita
Nucula parva
Yoldia fabula
Mayalina orthonotus
Pleurophorus tropidophorus
Euphemus carbonarius
Gastrioceras angulatum

CITATIONS:

Taff, J. A., U. S. Geol. Survey, Coalgate folio (No. 74), 1901, Atoka folio (No. 79), 1902. U. S. Geol. Survey, Prof. Paper 31, p. 39, 1904.
Reeds, C. A., Okla. Geol. Survey, Bull. 3, 1910.
Wallis, B. F., The Geology and Economic Value of the Wapanucka Limestone of Oklahoma: Okla. Geol. Survey, Bull. 23, p. 102, 1915.
Morgan, Geo. D., Bureau of Geology, Bull. 2, 1924.

ATOKA FORMATION

NOMENCLATORS: J. A. Taff and G. I. Adams, 1900.

TYPE LOCALITY: Atoka, Oklahoma.

CHARACTER: Shales, with lenses and thin ledges of brown sandstone.

THICKNESS: 3,000 feet.

OCCURRENCE: The Atoka outcrops north of the Wapanucka limestone and south of the Hartshorne sandstone in Coal, Atoka, Pittsburg, Latimer, LeFlore, Pushmataha, and McCurtain counties and into Arkansas. In northern LeFlore County it is brought to the surface along the Milton and Backbone anticlines and in southern Pittsburg County along the Savanna Anticline.

AGE: Early Pennsylvanian (Pottsville).

CORRELATION: Lower part of Winslow formation and of Cherokee shale of northeastern Oklahoma, part of Glenn formation, and lower part of Strawn formation of Texas. The "Upper Jackfork" sandstone of Honess is correlated by him with the Atoka. Miser, in compiling the State map, has excluded this "Upper Jackfork" from the Jackfork formation and has designated it as Atoka. (See footnote, page 37.)

CHARACTERISTIC FOSSILS:

Dielasma subspatulatum	Hustedia mormoni
Spiriferina kentuckyensis	Allorisma terminale
Composita subtilita	Pharkidonotus percarinatus

CITATIONS:

Taff, J. A., and Adams, G. I., U. S. Geol. Survey, 21st Ann. Rept., pt. 2, 1900.
Taff, J. A., U. S. Geol. Survey, Coalgate folio (No. 74), 1901, Atoka folio (No. 79), 1902. U. S. Geol. Survey, Bull. 380, p. 289, 1909.
Collier, A. J., U. S. Geol. Survey, Bull. 326, p. 13, 1907.
Snider, L. C., Okla. Geol. Survey, Bull. 17, p. 8, 1914.
Smith, C. D., U. S. Geol. Survey, Bull. 541, p. 24, 1914.
Wallis, B. F., Okla. Geol. Survey, Bull. 23, 1915.
Morgan, Geo. D., Bureau of Geology, Bull. 2, 1924.

HARTSHORNE SANDSTONE

NOMENCLATOR: J. A. Taff, 1899.

TYPE LOCALITY: Hartshorne, Pittsburg County.

CHARACTER: Brown and yellowish-brown sandstone, usually massive but with occasional interbedded shales.

THICKNESS: 100-200 feet.

OCCURRENCE: The Hartshorne is exposed as a narrow zone across Coal, Atoka, Pittsburg, Latimer, and LeFlore counties into Arkansas, and flanks the Backbone and Milton Anticlines in LeFlore and eastern Haskell counties and the Savanna Anticline in southern Pittsburg County.

AGE: Early Pennsylvanian (Upper Pottsville).

CORRELATION: Lower part of Cherokee shale in Kansas and

northeast Oklahoma, part of Winslow formation, and the Strawn formation of Texas.

CITATIONS:

Taff, J. A. and Adams, G. I., U. S. Geol. Survey, 21st Ann. Rept., pt. 2, 1910.
Taff, J. A., U. S. Geol. Survey, Coalgate folio (No| 74), 1901, Atoka folio (No. 79), 1902. U. S. Geol. Survey, 22nd. Ann. Rept., pt. 3, p. 376, 1902.
Collier, A. J., U. S. Geol. Survey, Bull. 326, p. 15, 1907.
Snider, L. C., Okla. Geol. Survey, Bull. 17, p. 8, 1914.
Smith, C. D., U. S. Geol. Survey, Bull. 541, p. 25, 1914.
Morgan, Geo. D., Bureau of Geology, Bull. 2, 1924.

McALESTER SHALE

NOMENCLATOR: J. A. Taff, 1899.

TYPE LOCALITY: McAlester, Oklahoma.

CHARACTER: Taff divides the McAlester into three parts: The lower part consists of shale with some sandstone and contains the Hartshorne coal. The middle part is composed of three or four beds of sandstone separated by shale. The upper part is almost entirely shale and contains the McAlester coal.

THICKNESS: 2,000 feet.

OCCURRENCE: The effect of the folding which has taken place in eastern Oklahoma has been to expose the McAlester and other formations in a series of rather narrow zones throughout the region. The McAlester outcrops on the surface in the following counties: Pontotoc, Coal, Atoka, Pittsburg, Latimer, Haskell, and LeFlore, and into Arkansas. In the region of the Arkansas River it merges with the Winslow.

AGE: Pennsylvanian (Allegheny).

CORRELATION: Lower part of Cherokee shale, Winslow formation, and part of the Strawn formation of Texas.

CHARACTERISTIC FOSSILS: (Morgan).

Lophophyllum profundum
Stenopora mcalesterana
Orbiculoidea convexa
Marginifera splendens
Dielasma arkansanum
Composita wasatchensis
Allorisma terminale
Edmondia ovata
Deltopecten texanus
Astartella concentrica
Phanerotrema grayvillense
Bellerophon crassus
Phillipsia sangamonensis

CITATIONS:

Taff, J. A., U. S. Geol. Survey, 19th Ann. Rept., pt. 3, 1899.
Taff, J. A., and Adams, G. I., U. S. Geol. Survey, 21st Ann. Rept., pt. 2, 1900.
Taff, J. A., U. S. Geol. Survey, Coalgate folio (No. 74), 1901, Atoka folio (No. 79), 1902. U. S. Geol. Survey, 22nd. Ann. Rept., pt. 3, p. 377, 1902. U. S. Geol. Survey, Bull. 260, p. 384, 1905.
Collier, A. J., U. S. Geol. Survey, Bull. 326, p. 13, 1907.
Snider, L. C., Okla. Geol. Survey, Bull. 17, p. 8, 1914.
Smith, C. D., U. S. Geol. Survey, Bull. 541, p. 25, 1914.
Morgan, Geo. D., Bureau of Geology, Bull. 2, 1924.

SAVANNA SANDSTONE

NOMENCLATOR: J. A. Taff, 1899.

TYPE LOCALITY: Town of Savanna, Pittsburg County.

CHARACTER: Interbedded brown sandstones and shales, five or more members of each.

THICKNESS: Averages 1,150 feet.

OCCURRENCE: The Savanna is typically exposed as zones, usually two to four miles wide, following the wavelike structure caused by the anticlines and synclines throughout the region of its outcrop in Pontotoc, Coal, Atoka, Pittsburg, Latimer, LeFlore, and Haskell counties, and crosses the Canadian River northward into southern Muskogee and eastern McIntosh counties, finally thinning out and disappearing near Warner.

AGE: Pennsylvanian (early Allegheny).

CORRELATION: Part of the Strawn formation of Texas, part of the Glenn formation, and the middle part of the Cherokee shale of Kansas, Missouri and Oklahoma.

CHARACTERISTIC FOSSILS: (Morgan).

Archaeocidaris megastylus
Acanthoclema carbonarium
Rhombopora lepidodendroides
Crania modesta
Chonetes granulifer
Productus cora
Leda bellistriata
Acanthopecten carboniferus
Aviculopinna amerciana
Euphemus carbonarius
Astartella concentrica
Phanerotrema grayvillense
Bellerophon bellus
Bucanopsis meekiana
Coloceras liratum

CITATIONS:

Taff, J. A., U. S. Geol. Survey, 19th Ann. Rept., pt. 3, 1899.

Taff, J. A., and Adams, G. I., U. S. Geol. Survey, 21st Ann Rept., pt. 2, 1900.
Taff, J. A., U. S. Geol. Survey, Coalgate folio (No. 74), 1901, Atoka folio (No. 79), 1902. U. S. Geol. Survey, Bull. 260, p. 385, 1905. U. S. Geol. Survey, 22nd Ann. Rept., pt. 3, 1902.
Snider, L. C., Okla. Geol. Survey, Bull. 17, p. 9, 1914.
Smith, C. D., U. S. Geol. Survey, Bull. 541, p. 25, 1914.
Morgan, Geo. D., Bureau of Geology, Bull. 2, 1924.

BOGGY SHALE

NOMENCLATOR: J. A. Taff, 1899.

TYPE LOCALITY: Boggy Creek, Atoka and Coal counties.

CHARACTER: A thick and widely distributed formation, consisting largely of shales, with some sandstone, particularly in the upper part, and a few beds of limestone.

THICKNESS: Varying in different localities from 1,200 to 2,600 feet.

OCCURRENCE: The Boggy outcrops as a broad zone northeast of the Arbuckle Mountains in eastern Pontotoc County, thence east across northern Coal County, the southeast corner of Hughes and Pittsburg counties, into eastern McIntosh and western Muskogee counties. It also appears in the upper part of Sans Bois, Cavanal, and Sugar Loaf mountains in Latimer, Haskell, and LeFlore counties.

AGE: Pennsylvanian (Allegheny).

CORRELATION: Part of Cherokee shale and of Glenn formation of Oklahoma and part of Strawn formation of Texas.

CHARACTERISTIC FOSSILS: (Morgan).

Chactetes milleporaceus
Michelenia eugeneae
Ceriocrinus hemisphericus
Stenopora boggyensis
Chonetes mesolobus
Productus insinuatus
Dielasma bovidens
Spirifer cameratus
Ambocoelia planoconvexa
Aviculopecten occidentalis
Astartella concentrica
Pleurotomaria spirenema
Trepospira depressa
Bellerophon marcouanus
Naticopsis altonensis
Sphaerodoma gracilis
Pseudorthoceras seminolense

CITATIONS:

Taff, J. A., U. S. Geol. Survey, 19th Ann. Rept., pt. 3, 1899.

Taff, J. A., and Adams, G. I., U. S. Geol. Survey, 21st Ann. Rept., pt. 2, 1900.

Taff, J. A., U. S. Geol. Survey, Coalgate folio (No. 74), 1901, Atoka folio (No. 79), 1902. U. S. Geol. Survey, 22nd. Ann. Rept., pt. 3, p. 377, 1902. U. S. Geol. Survey, Muscogee folio (No. 132), 1906.

Snider, L. C., Okla. Geol. Survey, Bull. 17, p. 9, 1914.

Smith, C. D., U. S. Geol. Survey, Bull. 541, p. 25, 1914.

Morgan, Geo. D., Bureau of Geology, Circular 2, 1924. Bureau of Geology, Bull. 2, 1924.

THURMAN SANDSTONE

NOMENCLATOR: J. A. Taff, 1899.

TYPE LOCALITY: Former village of Thurman in northern Pittsburg County.

CHARACTER: Conglomerate, sandstone, and shaly beds.

THICKNESS: 80-250 feet.

OCCURRENCE: Exposed as a rather narrow band from near Ahlosa, southeast of Ada, Pontotoc County, thence east and northeast across northern Coal, southern Hughes, and northwest Pittsburg counties, into western McIntosh, eastern Okmulgee, and northwestern Muskogee counties.

AGE: Pennsylvanian (Allegheny).

CORRELATION: Upper part of Cherokee shale; also upper part of Strawn formation of Texas.

CHARACTERISTIC FOSSILS: (Morgan).

Productus cora
Hustedia mormoni
Schizodus affinis
Euphemus nodocarinatus
Allorisma sp.
Parallelodon sp.

CITATIONS:

Taff, J. A., U. S. Geol. Survey, Coalgate folio (No. 74), 1901.
Morgan, Geo. D., Bureau of Geology, Bull. 2, 1924.

STUART SHALE

NOMENCLATOR: J. A. Taff, 1901.

TYPE LOCALITY: Town of Stuart, in eastern Hughes County.

CHARACTER: Black and blue clay shales with beds of sandstone.

THICKNESS: 90-280 feet.

OCCURRENCE: The Stuart extends northeast from eastern Pontotoc County across northwestern Coal and southeastern Hughes, and into northwestern Pittsburg, western McIntosh, and eastern Okmulgee counties.

AGE: Pennsylvanian (Alleghany).

CORRELATION: Upper part of Cherokee shale.

CITATIONS:

Taff, J. A., U. S. Geol. Survey, Coalgate folio (No. 74), 1901.
Morgan, Geo. D., Bureau of Geology, Bull. 2, 1924.

SENORA FORMATION

NOMENCLATOR: J. A. Taff, 1901.

TYPE LOCALITY: Old postoffice of Senora, southern Okmulgee County.

CHARACTER: Brown sandstone, generally thick-bedded in northern part, thin and shaly in southwestern part.

THICKNESS: 140-485 feet.

OCCURRENCE: From eastern Pontotoc County the Senora extends northeast across northwestern Coal, eastern Hughes, and southeastern Okmulgee counties, as far as the Arkansas River near Stone Bluff, Wagoner County.

AGE: Pennsylvanian (Allegheny).

CORRELATION: Top of Cherokee shale.

CHARACTERISTIC FOSSILS: (Morgan).

Chonetes mesolobus
Productus cora
Pugnax rockymontana
Allorisma costatum
Leda bellistriata attenuata
Deltopecten texanus
Astarella varica
Trepospira depressa
Meekospira peracuta choctawensis
Conularia crustula
Coloceras liratum

CITATIONS:

Taff, J. A., U. S. Geol. Survey, Coalgate folio (No. 74), 1901.
Clark, R. W. and Bauer, C. M., Am. Assoc. Petroleum Geologists, Bull., vol. 5, p. 284, 1921.
Morgan, Geo. D., Bureau of Geology, Bull. 2, 1924.

CALVIN SANDSTONE

NOMENCLATOR: J. A. Taff, 1901.

TYPE LOCALITY: Town of Calvin, Hughes County.

CHARACTER: Thick-bedded, hard sandstone forming a prominent scarp, becoming friable, ferruginous, and shaly toward the south.

THICKNESS: 145-240 feet.

OCCURRENCE: From eastern Pontotoc County northeast across Hughes, Okfuskee, and Okmulgee counties, almost to Arkansas River near Stone Bluff, Wagoner County.

AGE: Pennsylvanian (Allegheny).

CORRELATION: Upper part of Cherokee shale of northern Oklahoma and southeastern Kansas.

CITATIONS:

Taff, J. A.; U. S. Geol. Survey, Coalgate folio (No. 74), 1901.
Clark, R. W. and Bauer, C. M., Am. Assoc. Petroleum Geologists, Bull., vol. 5, pp. 283-285, 1921.
Morgan, Geo. D., Bureau of Geology, Bull. 2, 1924.

WETUMKA SHALE

NOMENCLATOR: J. A. Taff, 1901.

TYPE LOCALITY: Old town of Wetumka, Hughes County.

CHARACTER: Clay shale, sandy shale, and thin sandstone.

THICKNESS: 120 feet.

OCCURRENCE: From eastern Pontotoc the Wetumka extends northeast across Hughes, Okfuskee, Okmulgee, and Tulsa counties to the Arkansas River.

AGE: Pennsylvanian (Allegheny).

CORRELATION: The Wetumka contains a limestone which appears to be the same as the Fort Scott limestone of Kansas and northern Oklahoma. It is also believed to correlate with lower part of the Graford formation of Texas.

CHARACTERISTIC FOSSILS: (Morgan).

Lophophyllum profundum
Lindstroemella patula
Schizodus alpinus
Trepospira depressa

Marginifera splendens
Ambocoelia planoconvexa
Nuculopsis ventricosa
Leda bellistriata
Anthroconeilo taffiana
Worthenia tabulata
Bellerophon marcouanus
Sphaerodoma brevis
Conularia crustula
Orthoceras tuba

CITATIONS:

Taff, J. A., U. S. Geol. Survey, Coalgate folio (No. 74), 1901.
Clark, R. W. and Bauer, C. M., Am. Assoc. Petroleum Geologists, Bull., vol. 5, p. 285, 1921.
Morgan, Geo. D., Bureau of Geology, Bull. 2, 1924.

WEWOKA FORMATION

NOMENCLATOR: J. A. Taff, 1901.

TYPE LOCALITY: Wewoka, Seminole County.

CHARACTER: Massive, brown, friable sandstone with interstratified soft blue clay shale and a thin limestone in lower part.

THICKNESS: 700 feet.

OCCURRENCE: The Wewoka outcrops from east-central Pontotoc County, thence northeast across Hughes, Seminole, Okfuskee, Okmulgee, and Tulsa counties.

AGE: Pennsylvanian (late Allegheny).

CHARACTERISTIC FOSSILS: (Girty and Morgan).

Fusulina inconspicua
Wewokella solida
Lophophyllum profundum var. radicosum
Hydreionocrinus patulus
Conularia crustula
Fistulipora carbonaria
Lindstroemella patula
Marginifera muricata
Marginifera splendens
Pugnax osagensis
Edmondia ovata
Nucula wewokana
Leda bellistriata
Schizodus alpinus
Lima rectifera
Dentalium semicostatum
Worthenia tabulata
Orestes nodosus
Sphaerodoma brevis
Pseudorthoceras knoxense
Metacoceras perelegans
Gastrioceras hyattianum
Phillipsia sangamonensis
Griffithides parvulus

CITATIONS:

Taff, J. A., U. S. Geol. Survey, Coalgate folio (No. 74), 1901.
Girty, G. H., New York Acad. Sci., Annals, vol. 21, p. 119, 1911. U. S.

Geol. Survey, Bull. 544, 1915.
Clark, R. W. and Bauer, C. M., Am. Assoc. Petroleum Geologists, Bull., vol. 5, p. 285, 1921.
Morgan, Geo. D., Bureau of Geology, Bull. 2, 1924.

HOLDENVILLE SHALE

NOMENCLATOR: J. A. Taff, 1901.

TYPE LOCALITY: City of Holdenville, county seat of Hughes County.

CHARACTER: Blue and yellow clay with beds of sandstone and thin siliceous limestones.

THICKNESS: 260 feet.

OCCURRENCE: The extreme southwestern occurrence of the Holdenville is near Lawrence, on the north flank of the Arbuckle Mountains in central Pontotoc County. From this point it is exposed as a rather narrow band, extending northeast through Pontotoc, Seminole, Okfuskee, Okmulgee, and Creek counties.

AGE: Pennsylvanian (late Allegheny).

CORRELATION: Probably equivalent to lower part of Pleasanton group of Kansas.

CHARACTERISTIC FOSSILS: (Morgan).

Fusulina sp.
Aulopora prosseri
Chaetetes schucherti
Stenopora carbonaria conferta
Polypora nodocarinata
Enteletes hemiplicatus
Meekella striatocostata
Chonetes granulifer armatus
Productus cora
Pustula semi-punctata
Dielasma bovidens
Allorisma terminale
Myalina swallovi
Pteria longa
Schizodus affinis
Euphemus carbonarius
Trachydomia wheeleri
Pseudorthoceras seminolense
Phillipsia sagamonensis

CITATIONS:

Taff, J. A., U. S. Geol. Survey, Coalgate folio (No. 74), 1901.
Gould, C. N. and others, Okla. State Univ., Research Bull., No. 3, p. 10, 1910.
Clark, R. W. and Bauer, C. M., Am. Assoc. Petroleum Geologists, Bull., vol. 5, p. 286, 1921.
Morgan, Geo. D., Okla. Geol. Survey, Circular 12, p. 9, 1923. Bureau of Geology, Bull. 2, 1924.

SEMINOLE CONGLOMERATE

NOMENCLATOR: J. A. Taff, 1901.

TYPE LOCALITY: Seminole Nation, now Seminole County.

CHARACTER: Conglomerate of white chert in brown matrix succeeded by brown sandstone.

THICKNESS: 20-150 feet.

OCCURRENCE: From central Pontotoc County the Seminole conglomerate trends northeast, crossing Seminole, Okfuskee and Creek counties.

AGE: Pennsylvanian (probably late Allegheny).

CORRELATION: Equivalent to a part of the Canyon group of Texas and probably to the Nowata shale of northern Oklahoma.

CHARACTERISTIC FOSSILS: (Morgan).

Lophophyllum profundum
Rhombopora lepidodendroides
Aulacorhynchus millepunctatus
Chonetes granulifer
Productus insinuatus
Spirifer cameratus
Astartella concentrica
Schizostoma catilloides
Orthoceras tuba

CITATIONS:

Taff, J. A., U. S. Geol. Survey, Coalgate folio (No. 74), 1901.
Clark, R. W. and Bauer, C. M., Am. Assoc. Petroleum Geologists, Bull., vol. 5, p. 286, 1921.
Moore, R. C., Am. Assoc. Petroleum Geologists, Bull., vol. 5, 1921.
Dunbar, C. O., Am. Jour. Sci., 5th ser., vool. 8, p. 242, 1924.
Morgan, Geo. D., Okla. Geol. Survey, Circular 12, p. 8, 1923. Bureau of Geology, Bull. 2, 1924.

FRANCIS FORMATION

NOMENCLATOR: Geo. D. Morgan, 1924.

TYPE LOCALITY: Francis, Pontotoc County.

CHARACTER: Dark blue and black shales, with beds of sandstone and thin limestones.

THICKNESS: 500 feet.

OCCURRENCE: From Fitzhugh, Pontotoc County, on the north slope of the Arbuckle Mountains, the Francis formation trends northeast across Pontotoc, Seminole, and Okfuskee counties.

AGE: Pennsylvanian (probably Conemaugh).

CORRELATION: Equivalent to the lower part, at least, of Graham formation of Texas, lower part of Kansas City group of Kansas, and in northern Oklahoma to a group of formations including the Coffeyville, Hogshooter, and Nellie Bly.

CHARACTERISTIC FOSSILS: (Morgan).

Lophophyllum profundum
Fistulipora sutulis
Polypora elliptica
Derbya crassa
Chonetes granulifer
Marginifera splendens
Dielasma bovidens
Schizodus meekanus
Worthenia tabulata
Euphemus carbonarius
Naticopsis altonensis
Orthoceras tuba
Phillipsi major

CITATION:

Morgan, Geo. D., Okla. Geol. Survey, Circular 12, pp. 10, 15, 1923. Bureau of Geology, Bull. 2, pp. 113-119, 1924.

BELLE CITY LIMESTONE

NOMENCLATOR: Boone Jones, in unpublished manuscript; first published by Geo. D. Morgan, 1923.

TYPE LOCALITY: Belle City village, in Seminole County.

CHARACTER: Tripartite formation, with white limestone above, variously colored shales between, and buff limestone below.

THICKNESS: Average 30 feet.

OCCURRENCE: The Belle City outcrops as a narrow band in north-central Pontotoc County, thence north across the Canadian River into middle Seminole County.

AGE: Pennsylvanian (Conemaugh).

CORRELATION: Approximately equivalent to a part of the Graham formation of Texas and to the Dewey limestone of northern Oklahoma.

CHARACTERISTIC FOSSILS:

Fenestella spinulosa
Polypora nodocarinata
Meekella striatocostata
Productus insinuatus
Pinna peracuta
Naticopsis remex
Sphaerodoma primigenia
Coloceras liratum

Spirifer cameratus
Aviculopecten occidentalis
Schistoceras fultonense

CITATIONS:

Jones, Boone, unpublished thesis in Library of Oklahoma University.
Morgan, Geo. D., Oklahoma Geol. Survey, Circular 12, 1923. Bureau of Geology, Bull. 2, pp. 123-125, 1924.

VAMOOSA FORMATION

NOMENCLATOR: Geo. D. Morgan, 1923 and 1924.

TYPE LOCALITY: Village of Vamoosa, Seminole County.

CHARACTER: Chert conglomerates, massive coarse and brown sandstone, and red and dark shale.

THICKNESS: Average 250 feet.

OCCURRENCE: From northern Pontotoc County the Vamoosa formation is exposed northward into southern Seminole County, where it splits into several formations which farther north are known as the Ochelata, Nelagoney, Elgin, and Pawhuska.

AGE: Pennsylvanian (Conemaugh).

CORRELATION: Ochelata, Nelagoney, Elgin, and Pawhuska formations of northeastern Oklahoma; probably Thrifty and Harpersville formations of Texas, and Chanute shale to the top of Shawnee group of Kansas.

CITATION:

Morgan, Geo. D., Okla. Geol. Survey, Circular 12, p. 15, 1923. Bureau of Geology, Bull. 2, pp. 125-128, 1924.

ADA FORMATION

NOMENCLATOR: Geo. D. Morgan, 1923 and 1924.

TYPE LOCALITY: City of Ada, county seat of Pontotoc County.

CHARACTER: Clays and shales, with limestone conglomerates and coarse sandstones.

THICKNESS: Average about 100 feet.

OCCURRENCE: From a point south of Roff, the Ada formation is exposed northward across Pontotoc County into Seminole County, where it merges with the lower red beds.

AGE: Pennsylvanian (Monongahela).

CORRELATION: Lower part of Buck Creek formation and upper part of Pawhuska formation of northern Oklahoma. Probably correlated with Pueblo formation of Texas and lower part of Wabaunsee group of Kansas.

CHARACTERISTIC FOSSILS: (Morgan).

Spirifer cameratus
Schizodus sp.
Bellerophon crassus
Pharkinodotus percarinatus
Sphaerodoma sp.

CITATION:

Morgan, Geo. D., Okla. Geol. Survey, Circular 12, p. 15, 1923. Bureau of Geology, Bull. 2, pp. 128-132, 1924.

PONTOTOC GROUP

NOMENCLATOR: Geo. D. Morgan, 1922.

TYPE LOCALITY: Pontotoc County.

CHARACTER: According to Morgan the Pontotoc terrane (group) consists of three formations, in ascending order; the Vanoss, Stratford, and Konawa, all names being from towns in the western part of the Stonewall quadrangle. The Vanoss consists of arkosic sandstones, conglomerates, shales, and thin limestones. The Stratford consists of the Hart limestone at the base and dark shales above. The Konawa is composed of red shales and coarse red sandstones "typical red beds".

THICKNESS: The average combined thickness of the three formations is given by Morgan as approximately 1,400 feet.

OCCURRENCE: The Pontotoc has been mapped around the southern and western part of the Arbuckle Mountains, beginning at a point northeast of Ardmore, Carter County. It has been followed northwest to a point at the northwest end of the mountains, where it is found to be less than 12 miles distant from the southeastern extension of the Duncan sandstone. Thence it outcrops east along the north slope of the Arbuckles, through southern Garvin and northwestern Murray counties, past Davis to Sulphur, thence northeast across western Pontotoc into western Seminole, and eastern Pottawatomie counties, where it merges with undifferentiated red beds.

AGE: Morgan believes that the lower part of the Pontotoc is Pennsylvanian and the upper part is Permian.

CITATIONS:

Morgan, Geo. D., Okla. Geol. Survey, Circular 11, p. 3, 1922. Okla. Acad. Sci., Proc., vol. 2, p. 87, 1922. Okla. Geol. Survey, Circular 12, p. 6, 1923. Bureau of Geology, Bull. 2, 1924.
Dunbar, C. O., Am. Jour. Sci., 5th ser., vol. 8, p. 242, 1924.

VANOSS FORMATION

NOMENCLATOR: Geo. D. Morgan, 1924.

TYPE LOCALITY: Town of Vanoss, western Pontotoc County.

CHARACTER: Alternating sandstones, conglomerates, shales, and thin limestones, all of which are arkosic.

THICKNESS: 250-650 feet.

OCCURRENCE: From the north flank of the Arbuckle Mountains near Sulphur, county seat of Murray County, the Vanoss extends northward across Murray and northwestern Pontotoc counties, and crossing the Canadian River is exposed in southeastern Pottawatomie and western Seminole counties, merging with the red beds.

AGE: Believed by Morgan to be late Pennsylvanian.

CORRELATION: Probably equivalent, in part at least, to Moran and Putnam formations of Texas, and to a part of the Wabaunsee group of Kansas.

CHARACTERISTIC FOSSILS: (Morgan).

Productus cora
Yoldia glabra
Myalina recurvirostris
Pleurotomaria arenaria
Naticopsis altonensis
Sphaerodoma texanus
Neuropteris ovata
Pecopteris arborescens
Pecopteris hemitelioides

CITATION:

Morgan, Geo. D., Bureau of Geology, Bull. 2, pp. 133-137, 1924.

STRATFORD FORMATION

NOMENCLATOR: Geo. D. Morgan, 1924.

TYPE LOCALITY: Town of Stratford, northeastern Garvin County.

CHARACTER: At the base, a series of limestones comprising the Hart limestone member. Above the Hart, the formation consists of dark-colored shales.

THICKNESS: 400 feet.

OCCURRENCE: Northern Carter, southern Garvin, northeastern Murray, and western Pontotoc counties.

AGE: Possibly basal Permian.

CORRELATION: Uncertain.

CHARACTERISTIC FOSSIL: (Morgan and Beede).

A few Bulimorpha sp.

CITATION:

Morgan, Geo. D., Bureau of Geology, Bull. 2, pp. 137-140, 1924.

KONAWA FORMATION

NOMENCLATOR: Geo. D. Morgan, 1924.

TYPE LOCALITY: Town of Konawa, southwestern Seminole County.

CHARACTER: Red shales and coarse red sandstone. "Typical red beds." (Morgan).

THICKNESS: 500 feet.

OCCURRENCE: The Konawa is exposed in northern Murray, east-central Garvin, eastern McClain, and southeastern Pottawatomie counties.

AGE: Probably early Permian.

CORRELATION: Not determined. Possibly in part at least equivalent to the Wellington formation of Kansas and Wichita formation of Texas.

CITATION:

Morgan, Geo. D., Bureau of Geology, Bull. 2, pp. 140-141, 1924.

OZARK MOUNTAIN SECTION AND CARBONIFEROUS OF NORTHERN OKLAHOMA

SPAVINAW GRANITE

NOMENCLATOR: N. F. Drake, 1897.

TYPE LOCALITY: Spavinaw Creek, northeast Mayes County, Oklahoma.

CHARACTER: Dark red, mottled, fine-grained granite.

THICKNESS: Unknown.

OCCURRENCE: The granite outcrops where it crosses Spavinaw Creek below the Tulsa water works dam. The exposure is about a quarter of a mile long and in places is 200 feet wide, standing as much as 20 feet above the surrounding sediments. Has been regarded by Drake, Snider, Hutchison, and others as a granite dike. Aurin, Clark, and Trager, however, consider that it is the top of a buried granite mountain now being uncovered by erosion.

AGE: Unknown; presumably pre-Cambrian.

CITATIONS:

Drake, N. F., Am. Philos. Soc., Proc., vol. 36, pp. 338 ff., 1897.
Hutchison, L. L., Okla. Geol. Survey, Bull. 2, p. 152, 1911
Snider, L. C., Okla. Geol. Survey, Bull. 24, pp. 50-53, 1915.
Aurin, F. L., Clark, G. C., and Trager, E. A., Am. Assoc. Petroleum Geologists Bull., vol. 5, 1921.
Gould, Chas. N., Geol. Soc. America, Bull., vol. 34. p. 547, 1923.

ORDOVICIAN DOLOMITE

CHARACTER: Hard, massive, gray dolomite.

THICKNESS: 200 feet +−.

OCCURRENCE: On both sides of the granite ridge at Spavinaw Creek, dipping 5 to 10 degrees away from the ridge. Also at a few other places in northeastern Oklahoma.

AGE: Lower Ordovician.

CORRELATION: Upper part of the Arbuckle limestone.

CITATIONS:

Drake, N. F., Am. Philos. Soc., Proc., vol. 36, 1897.
Siebenthal, C. E., U. S. Geol. Survey, Bull. 340, pp. 188-189, 1908.

Snider, L. C., Okla. Geol. Survey, Bull. 24, 1915.
Aurin, F. L., Clark, G. C. and Trager, E. A., Am. Assoc. Petroleum Geologists, Bull., vol. 5, 1921.

ST. PETER ("BURGEN") SANDSTONE[1]

NOMENCLATORS: St. Peter sandstone, D. D. Owen, 1847; "Burgen" sandstone, J. A. Taff, 1905.

TYPE LOCALITY: St. Peter River (now called Minnesota River), Minn., and Burgen Hollow, or small valley emptying into the Illinois River, in northern part of Cherokee County, Oklahoma.

CHARACTER: Is a massive white to brown, fine-grained sandstone of rounded grains and frosted surfaces, poorly cemented.

THICKNESS: 100 feet, base not exposed.

OCCURRENCE: The St. Peter ("Burgen") sandstone is brought to the surface along the Illinois River, northeast of Tahlequah. Folding carries it beneath the surface to the north, but according to Snider it again appears just north of the Tahlequah quadrangle, along the Illinois River.

AGE: Lower Ordovician.

CORRELATION: The "Burgen" sandstone of Oklahoma is correlated by Ulrich with the St. Peter sandstone of Northern Arkansas and numerous other States in the upper Mississippi Valley. On the Miser geologic map of Oklahoma the sandstone is called the St. Peter ("Burgen") sandstone. It also probably correlates with a part of the Blakely sandstone of the Ouachitas and the Simpson formation of the Arbuckles.

CITATIONS:

Taff, J. A., U. S. Geol. Survey, Tahlequah folio (No. 122), 1905, Muscogee folio (No. 132), 1906.
Siebenthal, C. E., U. S. Geol. Survey, Bull. 340, p. 188, 1908.
Snider, L. C., Okla. Geol. Survey, Bull. 9, p. 34, 1912. Okla. Geol. Survey, Bull. 24, p. 16, 1915.
Dake, C. L., Missouri Univ., School of Mines and Metal., Bull., Tech. ser., vol. 6, No. 1, p. 52, 1921.

[1] Miss Wilmarth comments as follows: "Many names have been used for what is now generally conceded to be the St. Peter sandstone. They all have been discontinued, including 'Burgen,' which is mapped as St. Peter ("Burgen") on the Oklahoma map."

The writer's preference is to use the Oklahoma name.

TYNER FORMATION

NOMENCLATOR: J. A. Taff, 1905.

TYPE LOCALITY: Tyner Creek in northern Adair County.

CHARACTER: Greenish or bluish shale, brown sandstone, calcareous cherty sandstone and limestone, abundant in the order named.

THICKNESS: 20-260 feet, averaging 150 feet.

OCCURRENCE: Along the Illinois and Barren Fork valleys and in Baumgartner Hollow northeast of Tahlequah, Cherokee, and Adair counties, and in isolated exposures extending into Arkansas. Also reported by Snider in a small outcrop at Spavinaw.

AGE: Middle and upper Ordovician. The lower portion on Illinois River contains fossils of Black River age, and the upper part contains fossils of Lorraine age.

CORRELATION: Viola limestone and Sylvan shale of the Arbuckles, and Bigfork chert and lower part of Talihina of the Ouachitas. It includes the "Wilcox" sand of the oil fraternity.

CHARACTERISTIC FOSSILS: (Ulrich, Taff, Snider).

Camarocladia rugosa
Orthis tricenaria
Liospira americana
Hormotoma gracilis
Psiloconcha inornata
Leperditia near fabulites
Ceraurus pleurexanthemus

CITATIONS:

Taff, J. A., U. S. Geol. Survey, Tahequah folio (No. 122), 1905, Muscogee folio (No. 132), 1906.
Siebenthal, C. E., U. S. Geol. Survey, Bull. 340, p. 189 1908.
Snider, L. C., Okla. Geol. Survey, Bull. 9, p. 35, 1912. Okla. Geol. Survey, Bull. 24, p. 17, 1915.
Aurin, F. L., Clark, G. C., and Trager, E. A., Am. Assoc. Petroleum Geologists, Bull., vol. 5, 1921.

ST. CLAIR MARBLE

NOMENCLATOR: R. A. F. Penrose, Jr., 1891.

TYPE LOCALITY: St. Clair Springs, Independence County, Arkansas.

CHARACTER: Pinkish white, coarsely-crystalline marble.

THICKNESS: 100-150 feet.

OCCURRENCE: Brought to the surface on the up-throw side of faults along Sallisaw Creek near Marble City, Sequoyah County, near Bunch, southern Adair County, and near Cookson on Illinois River in Cherokee County.

AGE: Silurian.

CORRELATION: Henryhouse shale, Missouri Mountain slate, and middle of Talihina chert.

CHARACTERISTIC FOSSILS: (Ulrich, Taff, Snider).

Callicrinus corrugatus
Pisocrinus gemmiformis
Stephanocrinus osgoodensis
Dalmanella elegantula
Plectambonites cf. transversalis
Strophonella striata
Atrypa nodostriata
Cypricardinia arata
Orthoceras cf. medullare

CITATIONS:

Penrose, R. A. F., Jr., Ark. Geol. Survey, Ann. Rept. for 1890, vol. 1, 1891.
Taff J. A., U. S. Geol. Survey, Tahlequah folio (No. 122), 1905, Muscogee folio (No 132), 1906.
Ulrich, E. O., Geol. Soc. Am., Bull., vol. 22, p. 559, 1911.
Snider, L. C., Okla. Geol. Survey, Bull. 9, p. 36, 1912. Okla. Geol. Survey, Bull. 24, p. 18, 1915.
Aurin, F. L., Clark, G. C., and Trager, E. A., Am. Assoc. Petroleum Geologists, Bull., vol. 5, 1921.
Miser, H. D., U. S. Geol. Survey, Bull. 734, p. 29, 1922. (Contains latest description of the St. Clair in the type region).

CHATTANOOGA SHALE

NOMENCLATOR: C. W. Hayes, 1891.

TYPE LOCALITY: Chattanooga, Tennessee.

CHARACTER: Black, slaty, bituminous shale of uniform texture, usually non-calcareous.

THICKNESS: From 26 feet on the east Bluffs of Grand River up to 90 feet at Spavinaw. Its variable thickness is probably due to the fact that it is preceded and followed by erosional unconformities.

OCCURRENCE: In Barren Fork Valley south of Westville; in stream valleys south of Cowskin River, along Spring and Spavi-

naw Creeks; on the Illinois River near the south line of the Siloam Springs quadrangle, near Marble City, Sequoyah County.

AGE: There has been considerable discussion as to the age of the Chattanooga shale. In former years it has usually been classified as upper Devonian, although the upper portion of the Black shale in Kentucky and elsewhere is known to contain Mississippian fossils. It therefore appears to be transitional and to represent upper Devonian and early Mississippian time.

CORRELATION: Woodford chert, upper part of Arkansas novaculite, and upper part of Talihina chert.

CITATIONS:

Hayes, C. W., U. S. Geol. Survey, Chattanooga folio (No. 6), 1894.
Taff, J. A., U. S. Geol. Survey, Tahlequah folio (No. 122), 1905, Muscogee folio (No. 132), 1906.
Siebenthal, C. E., U. S. Geol. Survey, Bull. 340, p. 189, 1908.
Snider, L. C., Okla. Geol. Survey, Bull. 24, pp. 20-21, 1915.
Aurin, F. L., Clark, G. C., and Trager, E. A., Am. Assoc. Petroleum Geologists, Bull., vol. 5, p. 122, 1921.
Schuchert, Chas., Geol. Soc. Am., Bull., vol. 33, p. 669, 1922.

BOONE LIMESTONE

NOMENCLATORS: J. C. Branner, 1888, and F. W. Simonds, 1891.

TYPE LOCALITY: Boone County, Arkansas.

CHARACTER: Interstratified chert and cherty limestone with variable amount of limestone and chert; in places composed almost entirely of chert, while in other places the greater proportion is limestone. At the base occurs the St. Joe limestone member.

THICKNESS: Variable, ranging from 100 to about 450 feet, average 300 feet.

OCCURRENCE: The Boone makes up the greater part of the Ozark Plateau east of Grand River in Oklahoma, occupying practically all of Delaware and Adair counties, the southern half of Ottawa County, the southeastern corner of Craig County, the east half of Mayes County, and northeast half of Cherokee County, and extending into northern Sequoyah, eastern Wagoner, and eastern Muskogee counties.

AGE: Mississippian. The upper portion is of Warsaw and Keokuk age, the lower part is of Burlington and Kinderhook age.

CORRELATION: Sycamore limestone of the Arbuckles.

CHARACTERISTIC FOSSILS: (Taff and Snider).

Lower Shales

Amplexus brevis
Cyathaxonia arcuata
C. minor
Cystodictya lineata
Chonetes logani
Productus ferngleneusis
Productella concentrica
Spirifer latior
Brachythyris peculiaris
Athyris lamellosa

Upper Cherts

Amplexus fragilis
Fenestella multispinosa
Hemitrypa proutana
Orthotetes keokuk
Productus setigerus
Spirifer logani
Reticularia pseudolineata
Capulus equilaterus

CITATIONS:

Branner, J. C., Ark. Geol. Survey, Ann. Rept., vol. 4, p. 27, 1888.
Simonds, F. W., Ark. Geol. Survey, Ann. Rept., p. 13, 1891.
Hopkins, T. C., Ark. Geol. Survey, Ann. Rept. for 1890, vol. 4, pp. 253-349, 1893.
Taff, J. A., U. S. Geol. Survey, Tahlequah folio (No. 122), 1905, Muscogee folio (No. 132), 1906.
Siebenthal, C. E., U. S. Geol. Survey, Bull. 340, p. 190, 1908.
Snider, L. C., Okla. Geol. Survey, Bull. 9, p. 37, 1912.
Smith, C. D., U. S. Geol. Survey, Bull. 541, p. 37, 1914.
Snider, L. C., Jour. Geol. vol. 22, p. 615, 1914. Okla. Geol Survey, Bull. 24, p. 22, 1915.
Perry, E. S., Okla. Geol. Survey, Bull. 28, 1917.
Berger, W. R., Am. Jour. Sci., 4th ser., vol. 48, p. 189, 1919. Am. Assoc. Petroleum Geolcgists, Bull., vol. 3, p. 212, 1919.
Aurin, F. L., Clark, G. C., and Trager, E. A., Am. Assoc. Petroleum Geologists, Bull., vol. 5, p. 122, 1921.
Trager, E. A., Am. Jour. Sci., 5th ser., vol. 5, p. 140, 1923.
Fath, A. E., U. S. Geol. Survey, Bull. 759, pp. 27-28, 1925.

MAYES FORMATION

NOMENCLATOR: L. C. Snider, 1915.

TYPE LOCALITY: Mayes County, Oklahoma.

CHARACTER: Dark-gray to black limestone, locally argillaceous, separated by thin beds of black shale.

THICKNESS: 3-100 feet, averaging 40 feet.

OCCURRENCE: Around the margin of the Boone limestone, usually resting disconformably on that formation.

AGE: Mississippian (Chester and older). Is composed of beds that are assigned by some geologists to the Moorefield

shale, Batesville sandstone, and lower part of Fayetteville shale. This name has not been used by the United States Geological Survey and therefore the Mayes formation is not differentiated on the geologic map.

CORRELATION: Lower part of Caney shale.

CHARACTERISTIC FOSSILS: (Snider).

Pachypora oklahomensis
Agassizocrinus sp.
Archimedes confertus
Lingula batesvillae
Chonetes cherokeensis
Productella hirsutiformis
Productus ovatus var. latior
Pustula subsulcata
Spirifer arkansanus
Composita rotunda
Sphenotus oklahomensis
Aviculopecten mayesensis
Pinna consimilis
Glyphioceras kentuckiense

CITATIONS:

Snider, L. C., Okla. Geol. Survey, Bull. 24, p. 27, 1915.
Aurin, F. L., Clark, G. C., and Trager, E. A., Am. Assoc. Petroleum Geologists, Bull., vol. 5, p. 123, 1921.

FAYETTEVILLE SHALE

NOMENCLATOR: F. W. Simonds, 1891.

TYPE LOCALITY: Fayetteville Valley, Arkansas.

CHARACTER: A dark bituminous shale weathering into prismatic blocks, with a few alternating thin limestone and sandstone strata or lentils. A ledge of sandstone sometimes occurring in the middle portion is known as the Wedington sandstone member.

THICKNESS: Lower portion 60-100 feet, sandstone member 20 feet, and upper shale 30 feet, making maximum thickness of 150 feet.

OCCURRENCE: The Fayetteville outcrops usually between the Boone and Mayes limestones below and the Pitkin limestone above, near the margin of the Ozark Mountains, especially in Ottawa, southeastern Craig, northern Delaware, central Mayes, eastern Wagoner, and Muskogee, southern Cherokee, and Adair, and northern Sequoyah counties.

AGE: Upper Mississippian (Chester).

CORRELATION: Partial time equivalent of the Caney shale, and of the Barnett shale of Texas.

CHARACTERISTIC FOSSILS: (Taff and Snider).

Zaphrentis spinulosa
Michelinia meekana
Pentremites sp.
Fenestella compressa
Archimedes invaginatus
Cystodictya nitida
Crania chesterensis
Productus cherokeensis
Diaphragmus elegans
Dielasma shumardana
Spirifer pellaensis
Spiriferina spinosa
Eumetria vera
Aviculopecten eurekensis
Myalina compressa

CITATIONS:

Simonds, F. W., Arkansas Geol. Survey, Ann. Rept. for 1888, vol. 4, pp. 42-48, 1891.

Taff, J. A., U. S. Geol. Survey, Tahlequah folio (No. 122), 1905, Muscogee folio (No. 132), 1906.

Snider, L. C., Okla. Geol. Survey, Bull. 9, p. 40, 1912.

Smith, C. D., U. S. Geol. Survey, Bull. 541, p. 37, 1914.

Snider, L. C., Jour. Geol. vol. 22, p. 620, 1914. Okla. Geol. Survey, Bull. 24, p. 35, 1915.

Aurin, F. L., Clark, G. C., and Trager, E. A., Am. Assoc. Petroleum Geologists, Bull., vol. 5, p. 123, 1921.

PITKIN LIMESTONE

NOMENCLATORS: G. I. Adams and E. O. Ulrich, 1904.

TYPE LOCALITY: Pitkin, Arkansas.

CHARACTER: "Varies from rusty-brown, granular, earthy and shaly strata at one extreme, to fine-textured, massive, bluish beds at the other," according to Taff. The granular and oolitic types are the most common.

THICKNESS: Varies up to 80 feet.

OCCURRENCE: In numerous outcropping patches, often brought up by faulting along the southern edge of the Ozarks, which are exposed in Oklahoma. Also on both sides of Grand River in Wagoner, Mayes, Craig, northern Delaware, and Ottawa counties.

AGE: Upper Mississippian (Chester).

CORRELATION: Part of Caney shale of Oklahoma and part of Barnett shale of Texas. It is the same as the "Archimedes" limestone of the early Arkansas geologists.

CHARACTERISTIC FOSSILS: (Snider).

Zaphrentis spinulosa
Archimedes sp.
Chonetes oklahomensis
Productus ovatus
Sphenotus quadriplicatum
Schizodus chesterensis
Aviculopecten pitkinensis
Platyceras subrotundum

Diaphragmus elegans
Reticularia setigera
Cycloceras randolphense
Griffithides pustulosus

CITATIONS:

Adams, G. I. and Ulrich, E. O., U. S. Geol. Survey, Prof. Paper 24, 1904.
Taff, J. A., U. S. Geol. Survey, Tahlequah folio (No. 122), 1905, Muscogee folio (No. 132), 1906.
Snider, L. C., Okla. Geol. Survey, Bull. 9, p. 41, 1912.
Smith, C. D., U. S. Geol. Survey, Bull. 541, p. 38, 1914.
Snider, L. C., Jour. Geol. vol. 22, p. 622, 1914. Okla. Geol. Survey, Bull 24, p. 39, 1915.
Aurin, F. L., Clark, G. C., and Trager, E. A., Am. Assoc. Petroleum Geologists, Bull., vol. 5, p. 123, 1921.

MORROW FORMATION

NOMENCLATORS: G. I. Adams and E. O. Ulrich, 1904.

TYPE LOCALITY: Morrow, Washington County, Arkansas.

CHARACTER: The Morrow usually consists of three members; the lower member is a sandstone, the Hale sandstone, containing fossiliferous limestone strata. The middle portion is a relatively hard, blue, fine-textured limestone with local sandstone lenses, becoming shaly at the top. The upper member is blue and black shale with local limestone lenses becoming arenaceous at the top.

THICKNESS: 100-120 feet.

OCCURRENCE: In isolated outcrops around the margin of the Ozarks, mostly terminated by faulting, in a belt running west from the Arkansas boundary in southern Adair County and through southwestern Cherokee County and into Wagoner County. An isolated outlier brought to the surface by an anticline occurs in Wagoner County a few miles northwest of Wagoner. The Morrow rests unconformably on the Pitkin limestone, and is overlain by younger Pennsylvanian strata to which in some areas the name Cherokee shale is applied and for which in other areas the name Winslow formation is used.

AGE: Lower Pennsylvanian (early Pottsville).

CORRELATION: Upper part of Caney shale and Wapanucka limestone; lower part of Glenn formation; also the Marble Falls limestone and Smithwick shale of Texas.

CHARACTERISTIC FOSSILS: (Mather).

Zaphrentis gibsoni
Lophophyllum profundum
Michelinia eugeneae
Rhipidomella pecosi
Meekella striaticostata
Productus morrowensis

Pentremites rusticus
Delocrinus pentanodus
Fenestella morrowensis
Polypora elliptica
Rhombopora snideri
Cystodictya morrowensis
Orbiculoidea missouriensis
Productus welleri
Spirifer opimus
Spiriferina transversa
Schizodus morrowensis
Platyceras parvum
Gastrioceras branneri
Griffithides morrowensis

CITATIONS:

Adams, G. I., and Ulrich, E. O., U. S. Geol. Survey, Prof. Paper 24, 1904.
Taff, J. A., U. S. Geol. Survey, Tahlequah folio (No. 122), 1905, Muscogee folio (No. 132), 1906.
Smith, C. D., U. S. Geol. Survey Bull. 541, p. 38, 1914.
Snider, L. C., Okla. Geol. Survey, Bull. 24, p. 44, 1915.
Mather, K. F., Denison Univ., Sci. Lab., Bull., vol. 18, 1915. (A report on the fauna of the Morrow of Arkansas and Oklahoma; contains a complete bibliography).
Aurin, F. L., Clark, G. C., and Trager, E. A., Am. Assoc. Petroleum Geologists, Bull., vol. 5, p. 123, 1921.

WINSLOW FORMATION

NOMENCLATOR: G. I. Adams, 1904.

TYPE LOCALITY: Winslow, Arkansas.

CHARACTER: Bluish and blackish clay shales grading into a more sandy phase in the middle portion, above which the shale again becomes more prominent. This upper portion has been separately mapped by Taff in the southern part of the Tahlequah quadrangle and named the Akins shale member.

THICKNESS: 1,050-1,100 feet.

OCCURRENCE: In Oklahoma the Winslow outcrops in a semicircular belt around the southwest margin of the Ozark Mountains, from Wagoner County south through Muskogee, and thence east through southern Cherokee, northern Sequoyah, and southern Adair counties into Arkansas.

AGE: Pennsylvanian.

CORRELATION: Atoka formation, Hartshorne sandstone, and McAlester shale to the south; lower part of Cherokee shale to the north; lower part of Glenn formation; and probably the lower part of Strawn formation of Texas.

CITATIONS:

Adams, G. I., U. S. Geol. Survey, Prof. Paper 24, p. 29, 1904.
Taff, J. A., U. S. Geol. Survey, Tahlequah folio (No. 122), 1905, Muscogee folio (No. 132), 1906.

Purdue, A. H., U. S. Geol. Survey, Winslow folio (No. 154), 1907.
Snider, L. C., Okla. Geol. Survey, Bull. 17, p. 10, 1914. Okla. Geol. Survey, Bull. 24, p. 45, 1915.

CHEROKEE SHALE

NOMENCLATORS: E. Haworth and M. Z. Kirk, 1894.

TYPE LOCALITY: Cherokee County, Kansas.

CHARACTER: Variable colored shales, from light gray to yellowish-brown and jet black, with considerable lithologic variation both vertically and laterally from fine-grained shale to sandy shales and sandstones. The sandstones are the source of much oil. The well-known Bartlesville sand belongs to this formation. The formation also contains several beds of coal.

The Bluejacket sandstone member, 50 to 60 feet thick, occurs near the middle of the formation. It consists sometimes of a solid mass of sandstone but is usually separated into several beds by intervening shales, and was named by D. W. Ohern (unpublished mss.) for exposures near the town of Bluejacket, Craig County. The Bluejacket is the basal sand of the Bartlesville group of oil sands. Its base is shown on Miser's geologic map of Oklahoma.

THICKNESS: About 450 feet at the Kansas-Oklahoma line, gradually increasing southward in thickness to 960 feet at Pryor Creek, and with continuously greater thickness to the south.

OCCURRENCE: The Cherokee is exposed in a broad continuous belt from north-central Wagoner County and southeast Rogers through northwestern Mayes, central Craig, and northwest Ottawa counties to Kansas.

AGE: Early Pennsylvanian (late Pottsville and early Allegheny).

CORRELATION: The Cherokee is apparently the time equivalent of a series of shales and sandstones which become increasingly thicker to the south, including, from below upward, the Atoka, Hartshorne, McAlester, Savanna, Boggy, Thurman, Stuart, Senora, and Calvin formations. It is also equivalent to a part of the Glenn formation, and to a part or all of the Strawn formation of Texas. The lower portion of the Cherokee is the equivalent of the Winslow formation.

CHARACTERISTIC FOSSILS: (White, Adams, Girty, Bennett, Beede).

Pseudopecoperis squamosa
Sphenopteris denticulata
Pecopteris unita
Neuropteris rarinervis
Annularia stellata
Lingula carbonaria
Chonetes mesolobus
Pustula nebraskensis
Marginifera muricata
Spirifer cameratus
Composita subtilita

CITATIONS:

Haworth, E. and Kirk, M. Z., Kans. Univ. Quarterly, vol. 2, p. 195, 1894.
Siebenthal, C. E., U. S. Geol. Survey, Bull. 340, p. 190, 1908.
Ohern, D. W., Okla. State Univ., Research Bull., No. 4, 1910.
Gould, C. N., Ohern, D. W. and Hutchison, L. L., Okla. State Univ., Research Bull., No. 3, 1910.
Ohern, D. W. and Garrett, R. E., Okla. Geol. Survey, Bull. 16, p. 16, 1912.
Smith, C. D., U. S. Geol. Survey, Bull. 541, p. 39, 1914.
Snider, L. C., Okla. Geol. Survey, Bull., 24, p. 45, 1915.
Fath, A. E., U. S. Geol. Survey, Bull. 759, pp. 24-27, 1925.

FORT SCOTT LIMESTONE

NOMENCLATOR: G. C. Swallow, 1866.

TYPE LOCALITY: Fort Scott, Kansas.

CHARACTER: Consists of a lower limestone member 5 to 18 feet in thickness, a middle shale member 7-8 feet thick, and an upper limestone bed 7-8 feet thick. The Fort Scott is usually known as the "Oswego lime" by the oil fraternity. It forms the Wheeler oil "sand" of the Cushing field.

THICKNESS: 38-200 feet; average 50 feet.

OCCURRENCE: The Fort Scott outcrops in a belt running southwest from the Kansas line near Chetopa, varying in width from 1 to 10 miles, crossing Craig, Nowata, Rogers, and Tulsa counties, passing near the towns of Chelsea, Claremore and Catoosa, south of Broken Arrow near the Arkansas River. It thins rapidly and finally disappears a short distance south of Arkansas River.

AGE: Pennsylvanian (Allegheny).

CORRELATION: The Fort Scott overlies the Cherokee shale, and according to Bloesch and Miser it appears to pass into the upper part of the Wetumka shale of Okmulgee, Hughes, and Pontotoc counties to the south.

CHARACTERISTIC FOSSILS: (Girty, Adams, Beede, Bennett).

Lower Limestone

Fusulina cylindrica	Meekella striaticostata
Campophylum torquium	Productus cora
Rhipidomella pecosi	Trepospira sphaerulata

Middle Shale

Axophyllum rude	Ambocoelia planiconvexa
Orbiculoidea missouriensis	Spiriferina kentuckyensis
Chonetes flemingi	Spirifer camaratus

Upper Limestone

Fusulina cylindrica	Squamularia perplexa
Chaetetes milliporaceus	Hustedia mormoni
Rhombopora lepidodendroides	Aviculopecten occidentalis
Marginifera wabashensis	

CITATIONS:

Swallow, G. C., Kansas Geol. Survey, Prelim. Rept., p. 25, 1866.
Adams, G. I., U. S. Geol. Survey, Bull. 211, p. 61, 1903.
Siebenthal, C. E., U. S. Geol. Survey, Bull. 340, p. 192, 1908.
Ohern, D. W., Okla. State Univ., Research Bull., No. 4, 1910.
Gould, C. N., Ohern, D. W., and Hutchison, L. L., Okla. State Univ., Research Bull., No. 3, 1910.
Ohern, D. W., and Garrett, R. E., Okla. Geol. Survey, Bull. 16, p. 16, 1912.
Smith, C. D., U. S. Geol. Survey, Bull. 541, p. 40, 1914
Berger, W. R., Jour. Geol., vol. 26, p. 618, 1918.
Fath, A. E., U. S. Geol. Survey, Bull. 759, 1925.

LABETTE SHALE

NOMENCLATOR: E. Haworth, 1898.

TYPE LOCALITY: Labette County, Kansas.

CHARACTER: Clay shales, sandy clays, bluish to greenish in color that locally shade into brownish shaly sandstone.

THICKNESS: 20-80 feet in Kansas, thickening to the south. In Craig County, Oklahoma, 100-120 feet.

OCCURRENCE: The Labette as exposed in Oklahoma outcrops in a narrow belt beginning at the Kansas State line in Big Creek Valley, running southwesterly to the junction of Big Creek and Verdigris River, which has cut its valley through the Labette shale, to Catoosa, where the river leaves it, turning easterly. The shale continues southwest, becoming the basal member of R. H. Wood's Broken Arrow formation (unpublished mss.), near the town of Broken Arrow. It rests on the Fort Scott limestone and is overlain by the Pawnee limestone.

AGE: Pennsylvanian (Allegheny).

CHARACTERISTIC FOSSILS: (White, Adams, Girty).

Lophophyllum profundum
Rhombopora lepidodendroides
Derbya crassa
Chonetes mesolobus
Nuculopsis ventricosa

CITATIONS:

Haworth, E., Kans. Univ. Geol. Survey, vol. 3, 1898.
Siebenthal, C. E., U. S. Geol. Survey, Bull. 340, p. 193, 1908.
Ohern, D. W., Okla. State Univ., Research Bull., No. 4, p. 17, 1910. Geol. Soc. Amer., Bull., vol. 22, p. 720, 1911.
Ohern, D. W. and Garrett, R. E., Okla. Geol. Survey, Bull. 16, p. 16, 1912.
Greene, F. C., Am. Assoc. Petroleum Geologists, Bull. vol. 2, p. 119, 1918.

PAWNEE LIMESTONE

NOMENCLATOR: G. C. Swallow, 1866.

TYPE LOCALITY: Pawnee Creek, Bourbon County, Kansas.

CHARACTER: Massive, ferruginous limestone, generally white or gray but in places bluish; fossiliferous, weathering into large boulders and reddish iron rusty soil. Yields abundant spongy chert fragments on weathering.

THICKNESS: 35 feet at the Kansas line, increases southward to 40 feet in central Nowata County, Oklahoma.

OCCURRENCE: From Kansas State line south along west bank of Big Creek and along the Verdigris River from Nowata to a point near Oologah. It rests on the Labette shale and is overlain by the Bandera shale.

AGE: Pennsylvanian (Allegheny).

CORRELATION: The Pawnee is the lower of a group of three formations (the Pawnee, the Bandera shale, and the Altamont limestone) which south of the vicinity of Talala, Rogers County, is known under the collective name of Oologah limestone. This latter is known to the drillers as the "Big lime." In the vicinity of the Arkansas River in southern Tulsa County the Pawnee, with other formations, merges into the Broken Arrow formation.

CHARACTERISTIC FOSSILS: (Adams, Girty, Beede).

Fusulina cylindrica
Meekella striaticostata
Productus semireticulatus cora
Pustula nebraskensis
Marginifera wabashensis
Pugnax utah
Dielasma bovidens
Spirifer cameratus
Ambocoelia planiconvexa
Deltopecten occidentalis
Schizostoma catilloides
Composita subtilita
Hustedia mormoni

CITATIONS:

Swallow, G. C., Kans. Geol. Survey, Preliminary Rept., pp. 24-25, 1866.
Drake, N. F., Am. Philos. Soc., Proc., vol. 36, p. 377, 1897.
Siebenthal, C. E., U. S. Geol. Survey, Bull. 340, p. 193, 1908
Ohern, D. W., Okla. State Univ., Research Bull., No. 4, 1910.
Ohern, D. W., and Garrett, R. E., Okla. Geol. Survey, Bull. 16, p. 15, 1912.
Beede, J. W., Okla. Geol. Survey, Bull. 21, p. 9, 1914.

BANDERA SHALE

NOMENCLATOR: G. I. Adams, 1903.

TYPE LOCALITY: Bandera, Bourbon County, Kansas.

CHARACTER: Bluish-black clay shale, slightly arenaceous in places, weathering greenish and yellowish, becoming somewhat more arenaceous to the north in Kansas. It thins rapidly to the south.

THICKNESS: 60-100 feet in Kansas, but gradually thins to the south, disappearing near Talala by the coalescing of the Pawnee limestone below and the Altamont limestone above which there form the Oologah limestone. The Bandera rests on the Pawnee limestone and is overlain by the Altamont limestone.

OCCURRENCE: The Bandera outcrops in a narrow lens-like belt from a point near Talala northeast to the Kansas-Oklahoma State line, where it crosses into Kansas.

AGE: Pennsylvanian (Allegheny).

CORRELATION: See under Pawnee limestone.

CITATIONS:

Adams, G. I., U. S. Geol. Survey, Bull. 211, p. 32, 1903.
Siebenthal, C. E., U. S. Geol. Survey, Bull. 340, p. 193, 1908.
Ohern, D W., Okla. State Univ., Research Bull., No. 4, 1910.
Ohern, D. W. and Garrett, R. E., Okla. Geol. Survey Bull. 16, p. 15, 1912.

ALTAMONT LIMESTONE

NOMENCLATOR: G. I. Adams, 1896.

TYPE LOCALITY: Altamont, Kansas.

CHARACTER: A hard, rather siliceous limestone, bluish to bluish-gray in color, sometimes massive, but also stratified, permitting of quarrying in even blocks, and yielding abundant chert on weathering.

THICKNESS: Near the Kansas line is 30 feet plus; thickens slowly southward. After joining the Pawnee the combined thickness of the limestone (Oologah limestone) is 100 feet.

OCCURRENCE: The Altamont is exposed on the surface in a belt lying west of the Bandera shale outcrop, entering Oklahoma from Kansas in northeastern Nowata County, extending thence southwest to a point a few miles east of Nowata, to a point near Talala, where it merges with the Pawnee limestone, forming the Oologah limestone; thence south to southern Tulsa County, where it becomes part of the Broken Arrow formation. It rests on the Bandera shale north of the vicinity of Talala; south of Talala it rests on the Pawnee limestone.

AGE: Pennsylvanian (late Allegheny).

CHARACTERISTIC FOSSILS: (Adams, Girty, Beede).

Orbiculoidea missouriensis
Chonetes geinitzianus
Chonetes mesolobus
Pugnax utah
Dielasma bovidens
Nuculopsis ventricosa
Astartella vera
Trepospira sphaerulata
Phanerotrema grayvillense
Euphemus carbonarius

CITATIONS:

Adams, G. I., Kans. Univ. Geol. Survey, vol. 1, p. 22, 1896.
Drake, N. F., Am. Philos. Soc., Proc. vol. 36, 1897.
Ohern, D. W., Okla. State Univ., Research Bull., No. 4, 1910.
Ohern, D. W. and Garrett, R. E., Okla. Geol. Survey, Bull. 16, p. 15, 1912.

OOLOGAH LIMESTONE

NOMENCLATOR: N. F. Drake, 1897.

TYPE LOCALITY: Town of Oologah, Rogers County.

CHARACTER: Hard, massive, bluish, cherty limestone, becoming more shaly to the north. Known to drillers as "Big lime."

THICKNESS: 80-150 feet; averaging 100 feet.

OCCURRENCE: The Oologah is formed by the coalescing of two ledges of limestone, the Pawnee and Altamont, which farther north are separated by the Bandera shale. From the vicinity of Talala south the Oologah is exposed chiefly as conspicuous bluffs along the west bank of Verdigris River as far as Catoosa, thence to a point a few miles north of the town of Broken Arrow, where it merges with the Broken Arrow formation.

AGE: Pennsylvanian (probably late Allegheny and lower Conemaugh).

CORRELATION: Pawnee limestone, Bandera shale, and Altamont limestone of northern Oklahoma and Kansas; part of Broken Arrow formation and possibly equivalent to the Wewoka formation and the Holdenville shale.

CHARACTERISTIC FOSSILS: (Adams, Girty, Beede).

Axophyllum rude
Lophophyllum profundum
Prismopora serrata
Rhombopora lepidodendroides
Orbiculoidea missouriensis
Productus semireticulatus
Marginifera wabashensis
Spirifer cameratus
Squamularia perplexa
Spiriferina kentuckyensis
Composita subtilita
Cleiothyridina orbicularis
Hustedia mormoni

CITATIONS:

Drake, N. F., Proc. Am. Philos. Soc., vol. 36, p. 377, 1897.
Adams, G. I., U. S. Geol. Survey Bull. 211, p. 62, 1903.
Gould, C. N., Ohern, D. W. and Hutchison, L. L., State Univ. of Okla. Research Bull. No. 3, March, 1910.
Ohern, D. W., State Univ. of Okla., Research Bull. No. 4, December, 1910.

NOWATA SHALE

NOMENCLATOR: D. W. Ohern, 1910.

TYPE LOCALITY: Nowata, Oklahoma.

CHARACTER: A series of shales with a few interstratified sandstones. Contains one seam of coal in the type locality.

THICKNESS: 50 feet at Kansas State line, increasing to the south to 130 feet at Nowata, 600 feet at Tulsa, and possibly somewhat more south of the Arkansas River.

OCCURRENCE: From the Kansas-Oklahoma State line in a narrow belt running southwest through Dawson, skirting Tulsa to the east, to the Arkansas River, occupying the valleys between the limestone bluffs which lie above and below it.

AGE: Pennsylvanian (probably early Conemaugh).

CORRELATION: Probably equivalent in whole or in part to the Seminole conglomerate of east-central Oklahoma. Is same as the "Walnut" shale of Kansas; preoccupied by the Walnut clay of the Cretaceous of Texas.

CITATIONS:

Ohern, D. W., Okla. State Univ., Research Bull. No. 4, p. 23, 1910. Geol. Soc. Am., Bull. vol. 22, p. 720, 1911.
Ohern, D. W. and Garrett, R. E., Okla. Geol. Survey, Bull. 16, p. 15, 1912.

BROKEN ARROW FORMATION

(From unpublished manuscript by R. H. Wood.)

The Broken Arrow formation outcrops in a belt 10 to 15 miles wide, extending from the village of Broken Arrow southward to Arkansas River and beyond it for several miles. It embraces all the strata between the Fort Scott limestone below and the Dawson coal (the basal bed of the Coffeyville formation) above.

The belt of outcrop joins the outcrops of several equivalent formations at its north end and also at its south end. The equivalent formations to the north are the Nowata shale, Altamont limestone, Bandera shale, Pawnee limestone, and Labette shale, the youngest being named first. The Bandera shale, which separates the Pawnee and Altamont limestones at the northern border of the State, thins out in the vicinty of Talala. In consequence the two limestones are in contact south of this point, and to them the name Oologah limestone, also known as the "Big lime," has been applied. The Oologah limestone, in turn, thins out toward the south, in consequence of which the Nowata shale above the Oologah, and the Labette shale below the Oologah, are in contact south of Broken Arrow. To the combined formations, which are indistinguishable in lithologic character, the name Broken Arrow formation is applied. The name is taken from the village by this name.

The formation ranges in thickness from 350 to 500 feet or more; it is thickest toward the south. It consists mostly of green shale, but includes a few thin beds of limestone and some sandstone, notably in its lower part, south of Arkansas River[1].

LENAPAH LIMESTONE

NOMENCLATORS: C. N. Gould, D. W. Ohern, and L. L. Hutchison, 1910.

TYPE LOCALITY: Lenapah, Nowata County, Oklahoma.

CHARACTER: Consists of a single bed of dense-blue, partly-crystaline, fossiliferous limestone.

THICKNESS: 20 feet at Lenapah; 6 to 8 feet at Nowata.

OCCURRENCE: Enters Oklahoma from Kansas east of the Verdigris River, which is crossed by the outcrop before reaching

1 Note: The southern equivalents of the Broken Arrow are the Wewoka, Holdenville and Seminole formations.—C. N. Gould.

Lenapah. It forms the cap rock of many of the hills in north-central Nowata County. It has not been traced with certainty, south of Nowata, and appears to be absent in east-central Oklahoma. It underlies the Coffeyville formation and rests on Nowata shale.

AGE: Pennsylvanian (Conemaugh).

CITATIONS:

Gould and others, Okla. State Univ., Research Bull., No. 3, pp. 6-10, 1910.
Ohern, D. W., Okla. State Univ., Research Bull., No. 4, p. 25, 1910. Geol. Soc. Am., Bull., vol. 22, p. 721, 1911.
Ohern, D. W., and Garrett, R. E. Okla. Geol. Survey, Bull. 16, p. 15, 1912.

COFFEYVILLE FORMATION

NOMENCLATORS: F. C. Schrader and E. Haworth, 1905.

TYPE LOCALITY: Coffeyville, Kansas.

CHARACTER: The lower portion consists of homogeneous clay-shales of bluish or greenish color; in the upper part of the formation sandstones appear, which increase in thickness southward.

The Checkerboard limestone member of the Coffeyville formation lies near the base of the formation. It is 2½ to 3 feet thick, fine-grained and fossiliferous; bluish white on fresh surfaces but becomes yellowish-white on weathered surfaces. In bare areas the limestone presents a "checkerboard" appearance, due to solution channels along joints, which occur in two sets, the one crossing the other. From this characteristic feature the limestone was for years known as the "Checkerboard lime," but the geographic locality which is here designated as its type locality is the exposures on Checkerboard Creek in T. 15N., R. 11E. A good exposure may be seen at "Checkerboard Crossing" of the creek, near the east-west quarter line of sec. 22, T. 15N., R. 11E.

THICKNESS: 220-436 feet; averaging about 300 feet.

OCCURRENCE: The Coffeyville formation "extends in a broad belt 6 to 10 miles wide from Coffeyville, Kansas, to the south and west, crossing Nowata, southeastern Washington, Tulsa, eastern Creek, and northwestern Okmulgee counties into northern Okfuskee."

AGE: Pennsylvanian (Conemaugh).

CORRELATION: Due to its position above the Lenapah limestone and below the Hogshooter limestone the Coffeyville is

equivalent to the "Curl" formation of Ohern (a later name). It is also equivalent to the upper part (Dudley shale) of the Pleasanton group and the lower part of the Kansas City group of Kansas, including the Hertha, Ladore, Bethany Falls, Galesburg, Winterset, and Cherryvale formations.

CITATIONS:

Schrader, F. C. and Haworth, E., U. S. Geol. Survey, Bull. 260, p. 448, 1905.
Ohern, D. W., Okla. State Univ. Research Bull., No. 4, 1910.
Ohern, D. W. and Garrett, R. E., Okla. Geol. Survey, Bull. 16, p. 15, 1912.
Bloesch, Ed., Am. Assoc. Petroleum Geologists, Bull., vol. 3, pp. 260-262, 1919.

HOGSHOOTER LIMESTONE

NOMENCLATORS: Chas. N. Gould, D. W. Ohern, and L. L. Hutchison, 1910.

TYPE LOCALITY: Hogshooter Creek, Washington County, Oklahoma.

CHARACTER: Consists of a single bed of limestone, more massive northward and more argillaceous and thinner-bedded to the south.

THICKNESS: Variable, 10 feet at the State line; 6 to 8 feet on Hogshooter Creek; 4 feet at Ramona; and 20 feet at Lost City.

OCCURRENCE: Entering Oklahoma from Kansas in northwest Nowata County the Hogshooter outcrops as a narrow band trending southwestward. Along Hogshooter Creek east of Bartlesville the ledge covers a considerable area, near Ochelata it again becomes inconspicuous, but may be traced southwest near Ramona and Skiatook, in southeastern Osage County to and beyond the Arkansas River. On the hills south of the river west of Tulsa, where it has long been known locally as the "Lost City" limestone, the limestone thickens to 20 feet. Again thinning it may be traced south across Creek and northwestern Okmulgee counties and finally disappears a few miles west of Okemah. It is the basal formation of the Drum group.

AGE: Pennsylvanian (Conemaugh).

CITATIONS:

Gould and others, Okla. State Univ., Research Bull., No. 3, p. 12, 1910.
Ohern, D. W., Okla. State Univ., Research Bull., No. 4, p. 28, 1910. Geol. Soc. Am., Bull., vol. 22, p. 721, 1911.
Ohern, D. W. and Garrett, R. E., Okla. Geol. Survey, Bull. 16, p. 15, 1912.
Lloyd, E. R., Mather, K. F. and Ross, C. S., U. S. Geol. Survey, Bull. 686, 1919.

NELLIE BLY FORMATION

NOMENCLATOR: D. W. Ohern, in unpublished manuscript.

TYPE LOCALITY: Nellie Bly Creek, southern Washington County.

CHARACTER: "Alternating shales and hard, gray sandstones, the latter ranging in thickness from a few inches to several feet" from 15 feet on the Kansas line to 200 feet in southeastern Osage County. Middle formation of the Drum group. Rests on the Hogshooter limestone and is overlain by the Dewey limestone.

OCCURRENCE: Enters Oklahoma in northwestern Nowata County and extends southwest across Nowata, Washington, southeastern Osage and Creek counties as far as northern Okfuskee, where it merges with the Francis formation.

AGE: Pennsylvanian (Conemaugh).

CORRELATION: Upper part of Francis formation and probably a part of the Graham formations of Texas.

DEWEY LIMESTONE

NOMENCLATOR: D. W. Ohern, 1910.

TYPE LOCALITY: Dewey, Oklahoma.

CHARACTER: Bluish, semi-crystalline, usually somewhat shaly, but often massively-bedded, fossiliferous limestone.

THICKNESS: From 3 feet near Wann, to 20 feet at Dewey.

OCCURRENCE: From Kansas line, R. 15 E., the Dewey outcrops in a southwesterly direction, passing east of Dewey and Bartlesville in Washington County, where it attains its greatest areal extent, thence south past Ochelata and Ramona. It occurs in southern Osage County northwest of Sand Springs, and may be followed across Creek County, passing west of Sapulpa, near Kellyville and east of Bristow, continuing as far south as Okfuskee County. It rests on the Nellie Bly formation and is the upper formation of the Drum group. It is overlain by the Ochelata formation.

AGE: Pennsylvanian (Conemaugh).

CORRELATION: Belle City limestone of central-southern Oklahoma, and probably a part of the Graham formation of Texas.

CITATIONS:

Ohern, D. W., Okla. State Univ., Research Bull., No. 4, pp. 30-37, 1910.
Gould and others, Okla. State Univ., Research Bull. No. 3, p. 12, 1910.
Ohern, D. W. and Garrett, R. E., Okla. Geol. Survey, Bull. 16, p. 14, 1912.
Buttram, Frank, Okla. Geol. Survey, Bull. 18, p. 13, 1914.
Greene, F. C., Am. Assoc. Petroleum Geologists, Bull., vol. 2, p. 121, 1918. U. S. Geol. Survey, Bull. 686, 1919.
Fath, A. E., U. S. Geol. Survey, Bull. 661, p. 74, 1917. U. S. Geol. Survey, Bull. 759, 1925.

OCHELATA FORMATION

NOMENCLATOR: D. W. Ohern, in unpublished manuscript.

TYPE LOCALITY: Town of Ochelata, Washington County, Oklahoma.

CHARACTER: The Ochelata is essentially a shale formation with several sandstone and limestone members. The Avant limestone member, a ferruginous limestone, 5-57 feet thick, lies about 200 feet above its base. The Ochelata formation overlies the Dewey limestone and underlies the Nelagoney formation.

THICKNESS: 400 feet in Washington and Osage counties, gradually thickening to 480 feet or more to the south.

OCCURRENCE: The Ochelata outcrops as a zone 6 to 12 miles wide, crossing Washington, Osage, extreme eastern Pawnee, Creek, Okfuskee and northern Seminole counties, where it merges with the Vamoosa formation.

AGE: Pennsylvanian (Conemaugh).

CORRELATION: Equivalent to the Chanute, Iola, Lane, Plattsburg, Vilas and Stanton formations of Kansas; to the lower part of the Vamoosa formation of east-central Oklahoma; and to some part of the Canyon group of Texas.

NELAGONEY FORMATION

NOMENCLATOR: D. W. Ohern, in unpublished manuscript.

TYPE LOCALITY: Town of Nelagoney, Osage County, Oklahoma.

CHARACTER: The Nelagoney consists of shales, sandy shales interstratified with sandstones and with a limestone lentil 20 feet thick near the middle. It overlies the Ochelata formation and underlies the Elgin sandstone. Its basal bed is the Bigheart sandstone member.

THICKNESS: Averages 500 to 600 feet in Osage County.

OCCURRENCE: The Nelagoney is exposed as a zone 15 miles wide on the Kansas line in northeastern Osage County, gradually becoming narrower to the south. It crosses eastern Osage, eastern Pawnee and Creek, Okfuskee and northern Seminole counties and merges with the Vamoosa formation. In Creek, Okfuskee, and Seminole counties it is not differentiated from the Ochelata and Elgin formations.

AGE: Pennsylvanian (late Conemaugh).

CORRELATION: Douglas group of Kansas, which includes the Weston, Iatan, Lawrence and Oread formations; Vamoosa formation of east-central Oklahoma; and probably to a part of the Thrifty formation of Texas.

COPAN FORMATION

NOMENCLATOR: D. W. Ohern, 1910.

TYPE LOCALITY: Copan, Washington County, Oklahoma.

CHARACTER: The formation is composed of sandstone and gray shale, and in its upper part includes the Dewey limestone member.

THICKNESS: 600 to 700 feet.

OCCURRENCE: Bristow quadrangle in central Creek County.

AGE: Pennsylvanian (Conemaugh).

CORRELATION: The Copan formation is not designated by a separate pattern on the State map, but the strata assigned to it are there included in the lower part of the Ochelata formation, the Dewey limestone, and the Nellie Bly formation.

CITATIONS:

Ohern, D. W., Okla. State Univ., Research Bull., No. 4, pp. 29-34, 1910.
Geol. Soc. Am. Bull., vol. 22, p. 721, 1911.
Fath, A. E., U. S. Geol. Survey Bull. 759, pp. 16-17, 1925.

BRISTOW FORMATION

NOMENCLATOR: A. E. Fath, 1925.

TYPE LOCALITY: Bristow, Creek County, Oklahoma.

CHARACTER: The formation is an interbedded series of

sandstones and shales, lying below the Elgin sandstone and extending to the base of the Tiger Creek sandstone member. The sandstones are generally gray to yellowish-brown and are friable. The shales change from gray to red toward the south.

THICKNESS: 600 feet.

OCCURRENCE: Bristow quadrangle in central Creek County.

AGE: Pennsylvanian (Conemaugh).

CORRELATION: The Bristow formation is not designated by a separate pattern on the State map, but the strata assigned to it are there included in the Nelagoney formation and the upper part of the Ochelata formation.

CITATIONS:

Fath, A. E., U. S. Geol. Survey, Bull. 759, pp. 13-15, 1925.

ELGIN SANDSTONE

NOMENCLATOR: E. Haworth, 1898. (Name suggested by G. I. Adams.)

TYPE LOCALITY: Elgin, Chautauqua County, Kansas.

CHARACTER: The Elgin is a massive sandstone consisting usually of but a single member. It is more shaly to the north.

THICKNESS: Variable, from 50 to 210 feet.

OCCURRENCE: From the Kansas State line the Elgin is exposed as a prominent range of hills crossing Osage County, passing near Pawhuska, Wynona and Hominy. The outcrop crosses eastern Pawnee and western Creek counties, extending as far south as Seminole County, where it merges with the Vamoosa formation.

AGE: Pennsylvanian (late Conemaugh).

CORRELATION: Lower part of Kanwaka shale of Kansas, the basal formation of the Shawnee group; a part of the Vamoosa formation of east-central Oklahoma, and a part of the Cisco group of Texas.

CITATIONS:

Haworth, E., Kans. Univ. Geol. Survey, vol. 3, p. 64, 1898.
Ohern, D. W. and Garrett, R. E., Okla. Geol. Survey, Bull. 16, p. 13, 1912.
Buttram, Frank, Okla. Geol. Survey, Bull. 18, p. 11, 1914.
Greene, F. C., Am. Assoc. Petroleum Geologists, Bull., vol. 2, p. 122, 1918.
Heald, K. C., U. S. Geol. Survey, Bull. 686, 1919.
Fath, A. E., U. S. Geol. Survey, Bull. 661, p. 72, 1917. U. S. Geol. Survey Bull. 759, 1925.

PAWHUSKA FORMATION

NOMENCLATOR: J. P. Smith, 1894.

TYPE LOCALITY: Pawhuska, Oklahoma.[1]

CHARACTER: Three beds of heavy gray limestones with intervening shales. Sandstone and shale constitute a large part of the formation near the south end of its exposures.

THICKNESS: Variable up to 180 feet.

OCCURRENCE: The Pawhuska outcrops west of the Elgin sandstone across western Osage, eastern Pawnee, and northwestern Creek counties, to a point near Stroud, where it is merged into the upper part of the Vamoosa formation. It includes all beds between the Elgin sandstone below and the Buck Creek formation above.

AGE: Late Pennsylvanian (upper Conemaugh and Monongahela).

CORRELATION: The Pawhuska is the equivalent of at least a large part of the Shawnee group of Kansas, also the upper part of the Vamoosa formation and the lower part of the Ada formation of east-central Oklahoma, and probably to the upper part of the Thrifty formation of Texas.

CHARACTERISTIC FOSSILS: (Smith)

Derbya crassa	Marginifera splendens
Productus semireticulatus	Spirifer cameratus
Pustula nebrascensis	Composita subtilita

CITATIONS:

Smith, J. P., Jour. Geol. vol. 2, p. 199, 1894. Am. Philos. Soc., Proc., vol. 35, pp. 213-230, 1896.
Gould and others, Okla. State Univ., Research Bull., No. 3, p. 6, 1910.
Buttram, Frank, Okla. Geol. Survey, Bull. 18, pp. 8-10, 1914.
Beede, J. W., Okla. Geol. Survey, Bull. 21, p. 10, 1914.
Heald, K. C., U. S. Geol. Survey, Bull. 691, p. 66, 1918.
Fath, A. E., U. S. Geol. Survey, Bull. 759, pp. 11-12, 1925.

BUCK CREEK FORMATION

NOMENCLATOR: K. C. Heald in unpublished manuscript.

[1] According to L. B. Snider, the limestone later named Pawhuska was first found in 1892 by Herbert C. Hoover, while connected with the Arkansas Geological Survey under J. C. Branner. Hoover found the limestone at the "government lime kiln, three miles west of Pawhuska."

TYPE LOCALITY: Buck Creek, northern Osage County, Oklahoma.

CHARACTER: Limestones, shales and sandstones, extending from the top of the Pawhuska formation to the base of the overlying Grayhorse limestone member of the Sand Creek formation.

THICKNESS: 175 feet.

OCCURRENCE: Outcrops west of the Pawhuska limestone in Osage, Pawnee, and Payne counties, where it merges with undifferentiated red beds.

AGE: Late Pennsylvanian (Monongahela).

CORRELATION: Lower part of the Wabaunsee group of Kansas; also probably equivalent to upper part of the Ada formation and lower part of Pontotoc group of east-central Oklahoma.

SAND CREEK FORMATION

NOMENCLATOR: K. C. Heald, in unpublished manuscript.

TYPE LOCALITY: Sand Creek, northern Osage County.

CHARACTER: Two prominent limestone members, the Grayhorse, 1 feet thick at the base, and the Foraker, 60 to 110 feet thick at the top, with intervening shales and thin sandstones. Overlies Buck Creek formation and underlies Elmdale formation. Includes at base the Grayhorse limestone member.

THICKNESS: 200 feet.

OCCURRENCE: The Sand Creek formation outcrops in western Osage, eastern Pawnee and Payne counties where it merges with undifferentiated red beds.

AGE: Late Pennsylvanian (Monongahela).

CORRELATION: Middle part of the Wabaunsee group of Kansas, part of the Pontotoc group of east-central Oklahoma, and a part of the Cisco group of Texas.

CHARACTERISTIC FOSSILS: (Adams, Girty, Beede).

Its equivalent in Kansas Admire shales and Americus limestone carry fossils as follows:

Fusulina cylindrica
Lophophyllum profundum
Rhombopora lepidodendroides
Enteletes hemiplicatus
Derbya crassa
Meekella striaticostata
Chonetes granulifer
Chonetes verneuilianus
Pugnax utah
Hustedia mormoni

ELMDALE FORMATION

NOMENCLATORS: C. S. Prosser and J. W. Beede, 1902.

TYPE LOCALITY: Elmdale, Kansas.

CHARACTER: Consists of variagated shales with thin limestones, usually less than three feet in thickness, including the Cushing limestone member.

THICKNESS: About 100 feet.

OCCURRENCE: Exposed as a narrow belt below the Neva limestone and above the Sand Creek formation in western Osage, central Pawnee, and eastern Payne counties, as far as the Arkansas River, where it merges with undifferentiated red beds. The Cushing member of the Elmdale has been traced farther south into the red beds than any other limestone. It is exposed near Cushing (whence the name) and has been followed south across Lincoln County, passing near Chandler, Sparks, and Prague, and finally disappears north of the North Canadian River in northeastern Pottawatomie County.

AGE: Late Pennsylvanian (Monongahela).

CORRELATION: Middle of Wabaunsee group of Kansas, middle of Pontotoc group of central-southern Oklahoma, and upper part of Cisco group of Texas.

CHARACTERISTIC FOSSILS: (Prosser, Beede).

Fusulina cylindrica
Rhombopora lepidodendroides
Derbya crassa
Meekella striaticostata
Chonetes flemingi?
Chonetes granulifer
Productus cora
Spirifer cameratus
Ambocoelia planiconvexa
Composita subtilita
Patellostium montfortianum

CITATIONS:

Beede, J. W., Kans. Univ., Sci. Bull., vol. 1, p. 178, 1902.
Prosser, C. S., Jour. Geol. vol. 10, p. 708, 1902
Snider, L C., Oil and Gas in the Mid-Continent fields, Okla. City, Okla., p. 70, 1920. Jour. Geol. vol. 10, p. 708, 1902.

NEVA LIMESTONE

NOMENCLATORS: C. S. Prosser and J. W. Beede, 1902.

TYPE LOCALITY: Neva, Chase County, Kansas.

CHARACTER: Interbedded thin limestone with layers of shale. The lower portion contains many chert concretions. The formation thickens to the north and grades into limestone with a shaly member in the middle portion. It was originally called the "Dry bone" limestone by Swallow.

THICKNESS: 15-20 feet.

OCCURRENCE: The Neva is exposed from the Kansas line south in a sinuous outcrop passing across western Osage, central Pawnee counties, and south to a point near Ripley in Payne County, where it merges into undifferentiated red beds.

AGE: Generally classified as late Pennsylvanian, but according to Beede the base of the Neva, or possibly the base of the Elmdale, should be regarded as the base of the Permian.

CORRELATION: Upper part of Wabaunsee group of Kansas, upper part of Pontotoc group of central-southern Oklahoma, and upper part of Cisco group of Texas.

CITATIONS:

Beede, J. W., Kans. Univ., Sci. Bull., vol. 1, p. 180, 1902.
Prosser, C. S., Jour. Geol., vol. 10, p. 709, 1902
Beede, J. W., Okla. Geol. Survey, Bull. 21, p. 7, 1914.
Heald, K. C., U. S. Geol. Survey, Bull. 641, p. 23, 1916. U. S. Geol. Survey, Bull. 686, 1919.

ESKRIDGE SHALE

NOMENCLATORS: C. S. Prosser and J. W. Beede, 1902.

TYPE LOCALITY: Eskridge, Wabaunsee County, Kansas.

CHARACTER: The Eskridge consists of brown, green, and yellow shales, and includes beds of thin limestones.

THICKNESS: 40-60 feet.

OCCURRENCE: As a rather narrow band running north and south across western Osage, central Pawnee, and eastern Payne counties to the Arkansas River near Ripley, where it merges with the undifferentiated red beds. It is the top formation of the Wabaunsee group of Kansas.

AGE: Late Pennsylvanian.

CORRELATION: Upper part of Pontotoc group of central-eastern Oklahoma, and upper part of Cisco group of Texas.

CHARACTERISTIC FOSSILS: (Adams, Girty, Beede).

Ambocoelia planiconvexa
Deltopecten occidentalis
Myalina perattenuata
Myalina sp.
Pseudomontis hawni

CITATIONS:

Beede, J. W., Kans. Univ. Bull., vol. 1, p. 181, 1902.
Prosser, C. S., Jour. Geol. vol. 10, p. 709, 1902
Beede, J. W., Okla. Geol. Survey, Bull. 21, 1914.
Snider, L. C., Oil and Gas in the Mid-Continent Fields, Oklahoma City, Okla., p. 70, 1920.

COUNCIL GROVE GROUP

NOMENCLATOR: C. S. Prosser, 1902.

TYPE LOCALITY: Council Grove, Kansas.

CHARACTER: The Council Grove group consists of two formations, the Cottonwood limestone below and the Garrison formation above. The Cottonwood is described as a limestone of remarkable uniformity and extent, of light-gray to buff color, and massively bedded, usually intercalated with one or two thin shale or shaly limestone layers. The Garrison consists of yellowish shales intercalated with limestones.

THICKNESS: Variable, averaging 150 feet.

OCCURRENCE: The outcrop of the Council Grove in Oklahoma can best be traced by following the Cottonwood limestone, which is exposed as a sinuous line from Kansas southwesterly, passing west of Burbank, Osage County, west of Pawnee, merging into undifferentiated red beds about 5 miles east of Glencoe, Payne County.

AGE: According to present usage of the U. S. Geological Survey the base of the Cottonwood is taken as the base of the Permian.

CORRELATION: Possibly the uppermost part of the Pontotoc group and the Admiral formation of the Wichita group of Texas.

CHARACTERISTIC FOSSILS: (Adams, Girty, Beede).

Fusulina cylindrica
Rhombopora lepidodendroides
Meekella striaticostata
Chonetes granulifer
Productus semireticulatus
Composita subtilita
Deltopecten occidentalis

CITATIONS:

Prosser, C. S., Jour. Geol., vol. 10, p. 709, 1902. U. S. Geol. Survey Bull. 686, 1919.

Snider, L. C., Oil and Gas in the Mid-Continent Fields, p. 71, 1920.

CHASE GROUP

NOMENCLATOR: C. S. Prosser, 1895.

TYPE LOCALITY: Chase County, Kansas.

CHARACTER: The Chase group of Kansas is composed of the following formations, in ascending order: Wreford limestone 40 feet, Matfield shale 60 feet, Florence flint 20 feet, Fort Riley limestone 40 feet, Doyle shale 60 feet, and Winfield limestone 20 feet. The three heavy limestones, particularly the Wreford and Fort Riley, make up the Flint Hills of Kansas and northern Oklahoma. Of these limestones only the Fort Riley is indicated on the geologic map of the State.

THICKNESS: 240-300 feet.

OCCURRENCE: The various limestones mentioned above are exposed on the surface in eastern Kay, extreme western Osage, eastern Noble, and western Pawnee and Payne counties, where the ledges merge with the undifferentiated red beds. The horizon of the Fort Riley has been traced to the Cimarron River between Perkins and Ripley.

AGE: Lower Permian.

CORRELATION: Lower part of the Wichita and Asher formations of Southern Oklahoma.

CHARACTERISTIC FOSSILS:

Wreford Limestone (Adams, Girty, Beede).

Rhombopora lepidodendroides
Derbya robusta
Meekella striaticostata
Chonetes granulifer
Pustula nebraskensis
Productus semireticulatus
Composita subtilita
Deltopecten occidentalis
Myalina kansasensis
Parallelodon carbonarius
Pleurophorus calhouni
Schizostoma catilloides
Phillipsia scitula

Matfield Shale (Adams, Girty, Beede).

Axophyllum rude
Rhombopora lepidodendroides
Derbya robusta
Deltopecten occidentalis
Myalina perattenuata
M. subquadrata

Meekella striaticostata
Ambocoelia planiconvexa
Composita subtilita
Bakewellia parva
Allorisma terminale
Sedgwickia altirostrata

Florence Flint (Adams, Girty, Beede).

Meekella striaticostata
Productus semireticulatus
Ambocoelia planiconvexa
Composita subtilita
Chaenomya leavenworthensis
Deltopecten occidentalis
Myalina perattenuata
Pseudomonotis hawni
Bakewellia parva
Schizostoma catilloides
Phillipsia scitula

Fort Riley Limestone (Adams, Girty, Beede).

Fusulina cylindrica
Rhombopora lepidodendroides
Meekella striaticostata
Chonetes granulifer
Marginifera wabashensis
Ambocoelia planiconvexa
Composita subtilita
Allorisma terminale
Chaenomya leavenworthensis
Deltopecten occidentalis
Bakewellia parva
Schizostoma catilloides
Phillipsia major

Doyle Shale (Adams, Girty, Beede).

Derbya robusta
Meekella striaticostata
Productus semireticulatus
Composita subtilita
Deltopecten occidentalis
Bakewellia parva
Dentalium sp.

Winfield Limestone (Adams, Girty, Beede).

Archaeocidaris sp.
Septopora sp.
Derbya robusta
Productus semireticulatus
Composita subtilita
Deltopecten occidentalis
Myalina perattenuata
Aviculopinna illionisensis
Bakewellia parva

CITATIONS:

Prosser, C. S., Jour. Geol. vol. 3, pp. 771-786, 1895.
Prosser, C. S., Jour. Geol., vol. 10, p. 713, 1902. U. S. Geol. Survey, Bull. 686, 1919.
Adams, G. I., Girty, G. H., White, D., U. S. Geol. Survey Bull., 211, p. 123, 1903.
Snider, L. C., Oil and Gas in the Mid-Continent Fields, p. 71, 1920.

MARION FORMATION

NOMENCLATOR: C. S. Prosser, 1895.

TYPE LOCALITY: Marion County, Kansas.

CHARACTER: In Kansas the Marion formation includes, in ascending order, the following members: Luta limestone 30 feet thick, Enterprise shale 40 feet, Herington limestone 15 feet thick, and Pearl shale 70 feet thick.

THICKNESS: Variable, averaging 150 feet.

OCCURRENCE: The Marion is exposed in eastern Kay, western Osage, and Noble counties, where it merges with the red beds. Only the Herington limestone member is mapped.

AGE: Permian.

CORRELATION: Upper part of Wichita formation of southern Oklahoma.

CHARACTERISTIC FOSSILS:

Spirorbis sp.
Septopora sp.
Derbya robusta
Productus semireticulatus
Composita subtilita
Yoldia subscitula
Deltopecten occidentalis
Pseudomonotis hawni
Bakewellia parva
Phillipsia sp.
Soleniscus sp.

CITATIONS:

Prosser, C. S., Jour. Geol., vol. 3, pp. 786-789, 1895.
Gould, C. N., Kans. Acad. Sci., Trans., vol. 17, pp. 179-181, 1901.
Snider, L. C., Oil and Gas in the Mid-Continent Fields, Oklahoma City, Okla., p. 71, 1920.

WELLINGTON FORMATION

NOMENCLATOR: F. W. Cragin, 1896.

TYPE LOCALITY: Wellington, Sumner County, Kansas.

CHARACTER: Bluish-gray, greenish, and reddish shales, and thin beds of sandstones with important salt beds in the lower portion. Occasional thin limestone strata are present. It contains plant and vertebrate fossils.

THICKNESS: 255 feet in Kansas.

OCCURRENCE: Occupies an indefinite area in northwest Kay County, merging with the red beds to the south. Aurin and Clark would extend the term Wellington to include that part of the Enid formation below the Harper sandstone, which they state can be traced south across central Oklahoma to connect with the Duncan sandstone. The Wellington overlies the Marion formation, and

is followed by the Permian red beds, which appear to overlap it along its west border.

AGE: Permian.

CORRELATION: Uppermost part of Wichita formation or basal part of the Clear Fork formation of Texas.[1]

CHARACTERISTIC FOSSILS: (White, Sellards).

Plants Near Redrock, Noble County, Oklahoma, and Onaga, Kansas

Pecopteris arborescens
Pecopteris cyathea
Neuropteris permiana
Aspidiopsis coniferoides
Glenopteris simple
lineata
lobata
elongata
splendens
Callipteris conferta
whitii
sterlingi
Odontopteris reichiana
minor
Taeniopteris coriacea
newberriana
Walchia pinniformis
Aphelbia lacineata

CITATIONS:

Cragin, F. W., Washburn Coll. Lab. Nat. Hist., Bull., vol. 1, No. 3, pp. 85-86, 1885.

Gould, C. N., Kans. Acad. Sci., Trans., vol. 17, pp. 179-182, 1901.

Snider, L. C., Oil and Gas in the Mid-Continent Fields, p. 72, Oklahoma City, Okla., 1920.

Clark, G. C. and Aurin, F. L., Am. Assoc. Petroleum Geologists, Bull., vol. 8, p. 272, 1924.

1 In a paper read December 28, 1900, the present writer stated: "It may not be considered improbable that future investigation will demonstrate that the Wichita beds south of the Arbuckle Mountains are contemporaneous in time, with the lower division of the red beds in Kansas and Oklahoma."

THE PERMIAN RED BED SECTION

WICHITA AND CLEAR FORK FORMATIONS

NOMENCLATORS: E. T. Dumble and W. F. Cummins, 1890.

TYPE LOCALITIES: Wichita River, Texas; Clear Fork River, Texas.

CHARACTER: Red and gray clay shales interstratified in red and gray sandstone.

THICKNESS: 1,000 feet +.

OCCURRENCE: The terms Wichita and Clear Fork have been used as formation names in Texas since 1890. It has been shown that the same rocks are exposed on the north side of Red River in the region surrounding the Wichita Mountains and between that range and Red River. These are the "red beds of uncertain relations" as described by the writer in U. S. Geol. Survey, Water-Supply paper 148. It has not been found feasible thus far to separate the Wichita from the Clear Fork in Oklahoma. It is believed, however, that all the Permian rocks below the base of the Duncan sandstone, as exposed in the region south of the axis of the Anadarko Basin, may be considered as belonging to these formations. The base of the Wichita formation is believed by Miser to be the same as the base of the Asher formation of George D. Morgan, and if so, the Wichita overlies the Pontotoc group, as does the Asher formation. The pattern on the State map representing the Clear Fork and Wichita stops along an arbitrary line near the west end of the Arbuckle Mountains and joins the patterns for the Asher formation and the lower part of the Enid formation.

AGE: Lower Permian.

CORRELATION: The Wichita and Clear Fork are together equivalent to the lower part of the Enid and the Asher. The suggestion has been made that the Clear Fork may be equivalent to the lower part of the Enid, and the Wichita equivalent to the Asher.

CITATIONS:

Dumble, E. T., and Cummins, W. F., Texas Geol. Survey, 1st Ann. Rept., 1890.

Wegemann, C. H., U. S. Geol. Survey, Bull. 602, pp. 13-31, 1915

Munn, M. J., U. S. Geol. Survey, Bull. 547, p. 18, 1914.

Robinson, H. M., U. S. Geol. Survey, Bull. 726, p. 279, 1921.
Gould, C. N., Am. Assoc. Petroleum Geologists, Bull., vol. 8, pp. 322-341, 1924.

ASHER FORMATION

NOMENCLATOR: Geo. D. Morgan, 1924.

TYPE LOCALITY: Town of Asher, southern Pottawatomie County.

CHARACTER: "A continued section of typical red beds" (Morgan). Coarse red sandstone, some beds of gray sandstone, and red clay shale. Overlies Pontotoc group. Top not defined. As mapped by H. D. Miser, on geologic map of Oklahoma the top of the Asher is placed at the base of the Enid formation.

THICKNESS: 250 feet. +

OCCURRENCE: Garvin, Murray, McClain, and Pottawatomie counties.

AGE: Lower Permian.

CORRELATION: Not established.

CITATION:

Morgan, Geo. D., Bureau of Geology, Bull. 2, pp. 141-142, 1923.

ENID FORMATION

NOMENCLATOR: Chas. N. Gould, 1905.

TYPE LOCALITY: Enid, county seat of Garfield County.

CHARACTER: Red clays and shales with occasional beds of sandstone, particularly in eastern portion. Upper part gypsiferous.

THICKNESS: Averages 1,500 feet.

OCCURRENCE: The Enid formation as originally defined occupies the red beds plain extending from the Arbuckle Mountains north to the Kansas line, including the rocks lying between the undetermined base of the Permian and the Blaine Gypsum Hills. The formation is exposed in all or part of the following counties: Murray, Garvin, Stephens, McClain, Cleveland, Oklahoma, Pottawatomie, Canadian, Logan, Lincoln, Kingfisher, Blaine, Major, Garfield, Noble, Payne, Kay, Grant, Woodward, Alfalfa, Harper,

and Woods. Recent work in southwestern Oklahoma has led to the subdivision of the upper part of the rocks of that area heretofore mapped as Enid, into two formations, the Chickasha and Duncan. It has also led to the conclusion that the lower part of the typical Enid is there represented by the upper part of the rocks mapped as Clear Fork and Wichita formations on the State geologic map. The base of the Enid is believed by Aurin and Clark to be the same as the top of the Wellington formation of Kansas. There are several unsolved problems connected with the relations of the Enid.

AGE: Lower Permian.

CORRELATION: The Enid as shown on the State map is equivalent to several formations combined in southwestern Oklahoma. They are Chickasha, Duncan, Clear Fork, and possibly a part of the Wichita. The several formations in Kansas that are of the same age as the Enid are the Harper, Salt Plains, and Cedar Hills, and a part at least of the Flowerpot shale.

CITATIONS:

Gould, C. N., U. S. Geol. Survey, Water-Supply Paper, 148, 1905.
Snider, L. C., Okla. Geol. Survey, Bull. 11, p. 117, 1913.
Aurin, F. L., Okla. Geol. Survey, Bull. 30, p. 23, 1917.
Clapp, F. G., Mining and Metallurgy, No. 158, sec. 27, p. 4, 1920.
Reeves, Frank, U. S. Geol. Survey, Bull. 726, pp. 41-85, 1921.
Fenneman, N. M., U. S. Geol. Survey, Bull. 730, p. 120, 1922.
Gould, C. N., Am. Assoc. Petroleum Geologists, Bull., vol. 8, pp. 322-341, 1924

DUNCAN SANDSTONE

NOMENCLATOR: Chas. N. Gould, 1924.

TYPE LOCALITY: Duncan, county seat of Stephens County.

CHARACTER: Heavy bedded, gray to brown sandstone separated by shales.

"The term Duncan sandstone has two different definitions in geologic literature The usage followed in this report, and also on the State geologic map, corresponds to the definition as given in 1924 by Chas. N. Gould. According to the other definition, that of R. W. Sawyer, the term Duncan sandstone is applied to a formation that is composed of not o ly the Duncan sandstone of Gould but also the superjacent Chickasha form tion."—Misc.

THICKNESS: 40-200 feet.

OCCURRENCE: The Duncan is exposed as a narrow zone forming an escarpment facing away from the axis of the Anadarko basin. It is exposed in Jackson, Greer, Kiowa, Caddo, Co-

manche, Stephens, Garvin and McClain counties. The northern limit is at present not definitely known, but it is believed by Aurin and Clark that the Duncan corresponds to the middle part of the Harper sandstone of Kansas.

AGE: Permian.

CORRELATION: San Angelo sandstone, at base of the Double Mountain formation in Texas, and tentatively with at least a part of the Harper sandstone of Kansas.

CITATIONS:

Gould, C. N., Am. Assoc. Petroleum Geologists, Bull., vol. 8, pp. 322-341, 1924.
Sawyer, R. W., Am. Assoc. Petroleum Geologists, Bull., vol. 8, pp. 317-321, 1924.

CHICKASHA FORMATION

NOMENCLATOR: Chas. N. Gould, 1924.

TYPE LOCALITY: Chickasha, county seat of Grady County.

CHARACTER: Where typically exposed near the head of the Anadarko Basin in eastern Stephens County, the Chickasha consists of a "series of soft purple, greenish, gray or red sandstone and sandy shales, or reddish or brown mudstone conglomerates." —J. V. Howell. Farther north and west away from the head of the basin the lithologic character of the rocks changes, and near the base of the Gypsum Hills, both in northwestern and southwestern Oklahoma, the Chickasha consists of gypsum-impregnated red clay-shales.

THICKNESS: 175 feet +.

OCCURRENCE: Above the Duncan sandstone and usually in the same counties.

AGE: Permian.

CORRELATION: Lower part of Double Mountain formation of Texas. Approximately equivalent to the Flowerpot, Cedar Hills, and Salt Plains formations of Kansas.

CITATION:

Gould, C. N., Am. Assoc. Petroleum Geologists, Bull., vol. 8, pp. 322-341, 1924.

BLAINE GYPSUM

NOMENCLATOR: Chas. N. Gould, 1902 and 1924.

TYPE LOCALITY: Blaine County, Oklahoma.

CHARACTER: Two, or sometimes three, heavy beds of massive white gypsum (the Ferguson, Medicine Lodge, and Shimer members) separated by beds of red clay shale and dolomite.

THICKNESS: 75 feet.

OCCURRENCE: As originally described, outcrops in northwest Oklahoma, in Woods, Woodward, Harper, Major, Blaine and Canadian counties, but now found to extend around the head of the Anadarko Basin in Grady, Caddo, Stephens, and Comanche counties, and thence southwest through Kiowa, Greer, and Jackson counties to the Texas line.

AGE: Permian.

CORRELATION: Part of Double Mountain formation of Texas.

CITATIONS:

Gould, C. N., Okla. Dept. Geol. and Nat. Hist., 2nd Bien. Rept., p. 47, 1902.
U. S. Geol. Survey, Water-Supply Paper 148, p. 44, 1905
Snider, L. C., Okla. Geol. Survey, Bull. 11, p. 119, 1913.
Aurin, F. L., Okla. Geol. Survey, Bull., 30, p. 27, 1917.
Reeves, Frank, U. S. Geol. Survey, Bull. 726, pp. 41-85, 1921.
Clapp, F. G., Mining and Metallurgy, No. 158, sec. 27, p. 4, 1920.
Fenneman, N. M., U. S. Geol. Survey, Bull. 730, p. 121, 1922.
Gould, C. N., Am. Assoc. Petroleum Geologists, Bull., vol. 8, pp. 322-341, 1924
Sawyer, R. W., Am. Assoc. Petroleum Geologists, Bull., vol. 8, pp. 317-321, 1924.

DOG CREEK SHALE

NOMENCLATOR: F. W. Cragin, 1896.

TYPE LOCALITY: Dog Creek, in western Barber County, Kansas.

CHARACTER: Red clay shales with beds of dolomite.

THICKNESS: 30-400 feet.

OCCURRENCE: The Dog Creek of Oklahoma is exposed west of the line of the Blaine gypsum and usually in the same counties.

AGE: Permian.

CORRELATION: Part of Double Mountain formation of Texas.

CITATIONS:

Cragin, F. W., Colo. College Stud., vol. 6, pp. 3-39, 1896. Am. Geologist, vol. 19, p. 358, 1897.

Gould, C. N., Okla. Dept. Geol. and Nat. Hist., 2nd Bien. Rept., p. 49, 1902. U. S. Geol. Survey, Water-Supply Paper 148, 1905.

Snider, L. C., Okla. Geol. Survey, Bull. 11, p. 120, 1913.

Aurin, F. L., Okla. Geol. Survey, Bull. 30, p. 27, 1917.

Gould, C. N., Am. Assoc. Petroleum Geologists, Bull., vol. 8, pp. 322-341, 1924.

Sawyer, R. W., Am. Assoc. Petroleum Geologists, Bull., vol. 8, pp. 312-321, 1924.

VERDEN CHANNEL SANDSTONE

NOMENCLATORS: N. Meland and R. D. Reed, 1924.

TYPE LOCALITY: Town of Verden, Grady County, Oklahoma.

CHARACTER: Fossiliferous, conglomeratic sandstone with the appearance of an old stream channel.

THICKNESS: Not more than 10 feet thick nor more than 500 feet wide.

OCCURRENCE: The Verden occurs in Grady, Stephens, and Caddo counties, where it is exposed on a line of outcrops extending across the country like a railroad grade for 40 miles. At this writing the origin of the Verden has not been definitely determined, and we do not know whether it was originally a stream channel, tidal channel, or sea beach, or whether it was formed in some other manner. In Grady County it occupies the upper part of the Dog Creek shale.[1]

AGE: Permian.

CHARACTERISTIC FOSSILS: (Clifton).

Dielasma schucherti	Pleurophorus albequus
Bakewellia gouldii	Pleurotomaria capertoni
Bakewellia parva	Murchisonia gouldii

1 Other occurrences of fossiliferous "channel" sandstone occupying a horizon well up in the Whitehorse are at Whitehorse Springs and Wildcat Buttes in western Woods County, and along Chimney and Doe Creeks in northern Woodward County, Oklahoma. Also at Dozier Hills, Collingsworth County, Texas. At this time the relations of these various exposures are not well understood. Beede and Clifton, who have studied the fossils, find that they indicate Permian age. The following is a list of fossils that occur in the "channel" sandstone at Whitehorse Spring, Wildcat Buttes, and Dozier Mills. Beede and Clifton.

Schizodus ovatus
Deltopecten occidentalis
Dielasma schucherti
Conocardium oklahomense
Aviculopecten vanvleeti
Deltopecten occidentalis
Myalina permiana
Bakewellia gouldii
Strophostylus permianus

Bakewellia parva
Schizodus ovatus
Pleurophorus albequus
Pleurotomaria capertoni
Strophostylus permianus
Naticella transversa

CITATIONS:

Reed, R. D. and Meland, N., Jour. Geol., vol. 32, pp. 150-167, 1924.
Gould, C. N., Am. Assoc. Petroleum Geologists, Bull., vol. 8, pp. 322-341, 1924
Stephenson, C. D., Am. Asso. Petroleum Geologists, Bull., vol. 9, No. 3, pp. 626-631, 1925.
Clifton, R. L., Unpublished Thesis, University of Oklahoma, Norman.

WHITEHORSE SANDSTONE

NOMENCLATOR: Chas. N. Gould, 1905.

TYPE LOCALITY: Whitehorse Springs, Woods County. Originally called "Red Bluff" sandstone (preoccupied) by Cragin, from Red Bluff Postoffice, two miles north of Protection, Comanche County, Kansas.

CHARACTER: Friable, red, cross-bedded to regular-bedded sandstone, becoming more shaly to the north.

THICKNESS: Averages 200 feet.

OCCURRENCE: Occurs as a broad zone west of the Gypsum Hills, in Woods, Harper, Woodward, Major, Dewey, Blaine, Custer, Canadian, Caddo, Grady, Stephens, Comanche, Washita, Harmon, and Beckham counties.

AGE: Permian.

CORRELATION: Part of Double Mountain formation of Texas.

CITATIONS:

Gould, C. N., U. S. Geol. Survey, Water-Supply Paper 148, 1905.
Beede, J. W., Kans. Univ. Bull., vol. IV, No. 3, 1907.
Snider, L. C., Okla. Geol. Survey, Bull. 11, p. 121, 1913.
Aurin, F. L., Okla. Geol. Survey, Bull. 30, p. 28, 1917.
Ohern, D. W., Am. Assoc. Petroleum Geologists, Bull., vol. 2, p. 116, 1918.
Clapp, F. G., Mining and Metallurgy, No. 158, sec. 27, p. 4, 1920.
Reeves, Frank, U. S. Geol. Survey, Bull. 726, p. 51, 1921.
Fenneman, N. M., U. S. Geol. Survey, Bull. 730, 1922.
Gould, C. N., Am. Assoc. Petroleum Geologists, Bull., vol. 8, pp. 322-341, 1924.

Sawyer, R. W., Am. Assoc. Petroleum Geologists, Bull., vol. 8, pp. 312-321, 1924.
Clifton, R. L., Unpublished Thesis, University of Oklahoma, Norman.

DAY CREEK DOLOMITE

NOMENCLATOR: F. W. Cragin, 1896.

TYPE LOCALITY: Day Creek, Clark County, Kansas.

CHARACTER: Hard, white dolomite, weathering into scarps and buttes.

THICKNESS: 1-5 feet.

OCCURRENCE: The Day Creek dolomite is exposed along a line west of the Whitehorse sandstone in Woods, Woodward, Harper, Dewey, Custer, Blaine, Washita, and Caddo counties, capping prominent buttes and hills. Not mapped.

AGE: Permian.

CORRELATION: Part of Double Mountain formation of Texas.

CITATIONS:

Cragin, F. W., Colo. College Stud., vol. 6, pp. 3-44, 1896. Am. Geol., vol. 19, pp. 361-362, 1897.
Gould, C. N., Okla. Dept. Geol. and Nat. Hist., 2nd Bien. Rept., p. 51, 1902. U. S. Geol. Survey, Water-Supply Paper 148, p. 57, 1905.
Snider, L. C., Okla. Geol. Survey, Bull. 11, p. 122, 1913.
Aurin, F. L., Okla. Geol. Survey, Bull. 30, 1917.
Gould, C. N., Am. Assoc. Petroleum Geologists, Bull., vol. 8, pp. 322-341, 1924.
Sawyer, R. W., Am. Assoc. Petroleum Geologists, Bull., vol. 8, pp. 317-321, 1924.

WOODWARD GROUP

NOMENCLATOR: Chas. N. Gould, 1902.

TYPE LOCALITY: Woodward County, Oklahoma.

CHARACTER: Composed, in ascending order, of the Dog Creek shale, Whitehorse sandstone, and Day Creek dolomite, which have already been described under separate headings.

THICKNESS: Variable up to 500 feet.

OCCURRENCE: See occurrence of above named formations.

AGE: Upper Permian.

CORRELATION: Upper part of Double Mountain formation of Texas.

CITATIONS:

Gould, C. N., Okla. Dept. Geol. and Nat. Hist., 2nd Bien. Rept., p. 49, 1902. U. S. Geol. Survey, Water-Supply Paper 148, 1905.
Snider, L. C., Okla. Geol. Survey, Bull. 11, pp. 115-120, 1913.
Aurin, F. L., Okla. Geol. Survey, Bull. 30, p. 27, 1917.
Ohern, D. W., Am. Assoc. Petroleum Geologists, Bull., vol. 2, p. 116, 1918.
Clapp, F. G., Mining and Metallurgy, No. 158, sec. 27, p. 4, 1920.
Reeves, Frank, U. S. Geol. Survey, Bull. 726, p. 51, 1921.
Fenneman, N. M., U. S. Geol. Survey, Bull. 730, p. 122, 1922.
Gould, C. N., Am. Assoc. Petroleum Geologists, Bull., vol. 8, pp. 322-341, 1924.
Sawyer, R. W., Am. Assoc. Petroleum Geologists, Bull., vol. 8, pp. 317-321, 1924.

CLOUD CHIEF GYPSUM

NOMENCLATOR: Chas. N. Gould, 1924.

TYPE LOCALITY: Town of Cloud Chief, Washita County.

CHARACTER: Massive white or pinkish gypsum,usually irregularly bedded, with interstratified red clay shales. The Cloud Chief gypsum is the same as the "eastern area" of the "Greer" described in Water-Supply Paper, U. S. Geol. Survey No. 148, and by subsequent writers. Also the same as the "Cyril gypsum" of Clapp and of Reeves. For reasons for changing name see citation by Gould given below.

THICKNESS: Varies up to 115 feet.

OCCURRENCE: The Cloud Chief is exposed above the Whitehorse and Day Creek in Woodward, Dewey, Ellis, Roger Mills, Custer, Washita, Harmon, and Beckham counties.

AGE: Permian.

CITATIONS:

Clapp, F. G., Geology of the Cement Oil Field, Trans. Amer. Inst. Min. Met. Eng., vol. 65, pp. 156-64, 1921.
Reeves, Frank, Geology of the Cement Oil Field, U. S. Geol. Survey Bull., 726-B, 1921.
Gould, C. N., Am. Assoc. Petroleum Geologists, Bull., vol. 8, pp. 322-341, 1924.

QUARTERMASTER FORMATION

NOMENCLATOR: Chas. N. Gould, 1902.

TYPE LOCALITY: Quartermaster Creek, Roger Mills County.

CHARACTER: Soft, red sandstone, sandy clay and shales.

THICKNESS: 300 feet.

OCCURRENCE: Beckham, Washita, Custer, Dewey, Roger Mills, and Ellis counties.

AGE: The highest formation of the Permian exposed in Oklahoma.

CORRELATION: Upper part of Double Mountain formation of Texas.

CITATIONS:

Gould, C. N., Okla. Dept. Geol. and Nat. Hist., 2nd Bien. Rept., p. 57, 1902.
U. S. Geol. Survey, Water-Supply Paper 148, p. 72, 1905
Snider, L. C., Okla. Geol. Survey, Bull. 11, p. 124, 1913.
Aurin, F. L., Okla. Geol. Survey, Bull. 30, p. 31, 1917.
Gould, C. N., Am. Assoc. Petroleum Geologists, Bull., vol. 8, pp. 322-341, 1924.
Sawyer, R. W., Am. Assoc. Petroleum Geologists, Bull., vol. 8, pp. 317-321, 1924.

CRETACEOUS OF SOUTHERN OKLAHOMA

TRINITY SAND

NOMENCLATOR: R. T. Hill, 1888.

TYPE LOCALITY: Trinity River, Texas.

CHARACTER: The Trinity is composed of local coarse conglomerate and finely-packed yet incoherent sand, with occasional sandy clay, and limestone lenses.

THICKNESS: Variable from 200-1,528 feet.

OCCURRENCE: Exposed as a band 12 to 20 miles wide south of the Arbuckle and Ouachita Mountains, extending from Jefferson County east to Arkansas.

AGE: Comanche (Lower Cretaceous).

CORRELATION: In Texas the Trinity is a group divided into in ascending order, the Travis Peak sand, Glen Rose limestone, and Paluxy sand. In southern Oklahoma the Trinity sand was formerly called "Antlers" sand, a later name than Trinity.

CHARACTERISTIC FOSSILS: (Bullard).

Exogyra texana	Much carbonized and silicified wood
Ostrea crenulimargo	Bones of dinosauer

CITATIONS:

Hill, R. T., Ark. Geol. Survey, Ann. Rept. for 1888, vol. 2, pp. 116-152-176-179, 1888.

Taff, J. A., U. S. Geol. Survey, Atoka folio (No. 79), 1902. U. S. Geol. Survey, 22nd Ann. Rept., pt. 3, p. 697, 1902. U. S. Geol. Survey, Tishomingo folio (No. 98), 1903.

Taff, J. A., and Reed, W. J., U. S. Geol. Survey, Bull. 381, p. 35, 1909.

Larkin, Fierce, Jour. Geol., vol. 18, No. 1, p. 93, 1910.

Stephenson, L. W., U. S. Geol. Survey, Prof. Paper 120, p. 134, 1918.

Robinson, H. M., U. S. Geol. Survey, Bull. 726, p. 283, 1921

Bullard, Fred M., Okla. Acad. Sci. Proc., vol. 3, 1923. Okla. Geol. Survey, Bull. 33, pp. 16-22, 1925.

GOODLAND LIMESTONE

NOMENCLATOR: R. T. Hill, 1891.

TYPE LOCALITY: Town of Goodland, Choctaw County.

CHARACTER: Massive white fossiliferous limestone.

THICKNESS: 25-50 feet.

OCCURRENCE: A scarp-forming formation lying south of the

Trinity in Love, Marshall, Bryan, Choctaw, and McCurtain counties, dipping southeast.

AGE: Comanche (Lower Cretaceous).

CORRELATION: The Goodland is considered the approximate equivalent of the Edwards limestone, Walnut clay, and Comanche Peak limestone, which compose the Fredericksburg group of Texas.

CHARACTERISTIC FOSSILS: (Bullard).

Enallaster texanus
Exogyra texana
Protocardia texana
Cyprimeria texana
Schloenbachia autocarinata

CITATIONS:

Hill, R. T., Geol. Soc. Am., Bull. vol. 2, pp. 502-514, 1891.
Taff, J. A., U. S. Geol. Survey, Atoka folio (No. 79), 1902, Tishomingo folio (No. 98), 1903.
Taff, J. A., and Reed, W. J., U. S. Geol. Survey, Bull. 381, p. 35, 1909.
Stephenson, L. W., U. S. Geol. Survey, Prof. Paper 120, p. 135, 1918.
Hopkins, O. B., Powers, Sidney and Robinson, H. M., U. S. Geol. Survey, Bull 736, p. 3, 1922.
Bullard, Fred M., Okla. Acad., Sci., Proc., vol. 3, 1923. Okla. Geol. Survey, Bull. 33, pp. 22-30, 1925.

KIAMICHI FORMATION

NOMENCLATOR: R. T. Hill, 1891.

TYPE LOCALITY: Kiamichi River, Choctaw County, Oklahoma.

CHARACTER: Blue, friable shale with thin shell limestone beds in upper part.

THICKNESS: Variable up to 150 feet.

OCCURRENCE: Outcropping south of the Goodland limestone and in the same counties, dipping southeast.

AGE: Comanche (Lower Cretaceous).

CORRELATION: The Kiamichi and two succeeding formations, Caddo and Bokchito, represent the Washita group of Texas, which in the Panhandle of Oklahoma is represented by the Purgatoire formation.

CHARACTERISTIC FOSSILS: (Bullard).

Gryphea navia
Schloenbachia belknapi

CITATIONS:

Hill, R. T., Geol. Soc. Am., Bull., vol. 2, pp. 503-515, 1891.
Taff, J. A., U. S. Geol. Survey, Atoka folio (No. 79), 1902, Tishomingo folio (No. 98), 1903.
Taff, J. A., and Reed, W. J., U. S. Geol. Survey, Bull. 381, p. 35, 1909.
Stephenson, L. W., U. S. Geol. Survey, Prof. Paper 120, p. 138, 1918.
Hopkins, O. B., Powers, Sidney, and Robinson, H. M., U. S. Geol. Survey, Bull 736, p. 3, 1922.
Bullard, Fred M., Okla. Acad., Sci., Proc., vol. 3, 1923. Okla. Geol. Survey, Bull. 33, pp. 30-32, 1925.

CADDO LIMESTONE[1]

NOMENCLATOR: J. A. Taff, 1902.

TYPE LOCALITY: Town of Caddo, northern Bryan County, Oklahoma.

CHARACTER: Yellow and white limestone interstratified with thin marly beds.

THICKNESS: 60 feet.

OCCURRENCE: The Caddo outcrops as a line of low northward-facing escarpments in Love, Marshall, Bryan, Choctaw, and McCurtain counties.

AGE: Comanche (Lower Cretaceous).

CORRELATION: One of the formations of the Washita group.

CHARACTERISTIC FOSSILS: (Bullard).

Lower Caddo

Inoceramus comancheanus
Desmoceras brazoense
Schloenbachia trinodosa
Hamites comanchensis
fremonti
Hemiaster whitei

Upper Caddo

Holoaster simplex
Hemiaster elegans
Desmoceras brazoense
Exogyra americana
Schloenbachia leonensis

CITATIONS:

Taff, J. A., U. S. Geol. Survey, Atoka folio (No. 79), 1902, Tishomingo folio (No. 98), 1903.
Bullard. Fred M., Okla. Acad., Sci., Proc., vol. 3, 1923. Okla. Geol. Survey, Bull. 33, pp. 33-35, 1925.

[1] In a forthcoming report on Marshall County, by Fred M. Bullard, to be published as a bulletin of this survey, the Caddo limestone will be separated into the Duck Creek formation and the Ft. Worth limestone, well established formations in Texas.

BOKCHITO FORMATION[1]

NOMENCLATOR: J. A. Taff, 1902.

TYPE LOCALITY: Bokchito Creek, Bryan County.

CHARACTER: Red and blue shale with ferruginous limestones and lentils of friable sandstone.

THICKNESS: Variable up to 140 feet.

OCCURRENCE: The Bokchito outcrops south of the Caddo limestone and in the same counties. It dips southeast.

AGE: Comanche (Lower Cretaceous).

CORRELATION: One of the formations of the Washita group.

CHARACTERISTIC FOSSILS: (Bullard).

Protocardia texana

CITATIONS:

Taff, J. A., U. S. Geol. Survey, Atoka folio (No. 79), 1902, Tishomingo folio (No. 98), 1903.
Bullard, Fred M., Okla. Acad., Sci., Proc., vol. 3, 1923. Okla. Geol. Survey, Bull. 33, pp. 35-36, 1925.

BENNINGTON LIMESTONE[2]

NOMENCLATOR: J. A. Taff, 1902.

TYPE LOCALITY: Village of Bennington, eastern Bryan County.

CHARACTER: Massive dark-blue, shell limestone.

THICKNESS: 10-14 feet.

OCCURRENCE: Along an east-west outcrop in Love, Marshall, Bryan, Choctaw, and McCurtain counties.

AGE: Comanche (Lower Cretaceous).

CORRELATION: The Bennington is regarded as the time equivalent of the Del Rio clay and Buda limestone of Texas.

CHARACTERISTIC FOSSILS: (Bullard).

Kingena wasoensis
Exogyra arientina
Ostrea quadriplicata

[1] In a forthcoming report on Marshall County by Fred M. Bullard, the Bokchito formation will be separated into the Denton, Weno, and Pawpaw members, well established divisions in Texas.

[2] Equivalent to the Mainstreet limestone of Texas.

CITATIONS:

Taff, J. A., U. S. Geol. Survey, Atoka folio (No. 79), 1902, Tishomingo folio (No. 98), 1903.

Bullard, Fred M., Okla. Acad. Sci., Proc., vol. 3, 1923. Okla. Geol. Survey, Bull. 33, p. 37, 1925.

WOODBINE SAND

NOMENCLATOR: R. T. Hill, 1901.

TYPE LOCALITY: Village of Woodbine, Cooke County, Texas.

CHARACTER: Brown, friable sandstone locally indurated by ferruginous shale and shaly sandstone.

THICKNESS: Variable up to 200 feet.

OCCURRENCE: The Woodbine outcrops in southern Oklahoma as a broad band of sandy soil along an east-west zone, north of Red River in Marshall, Bryan, and Choctaw counties.

AGE: Has usually been considered the lowermost formation of the Upper Cretaceous.

CORRELATION: Dakota sandstone of the northern interior region. Is the same as the "Silo sandstone" of Taff, 1902. Woodbine has priority.

CITATIONS:

Hill, R. T., U. S. Geol. Survey, 21st Ann. Rept., pt. 7, p. 293, 1901.

Taff, J. A., U. S. Geol. Survey, Atoka folio (No. 79), 1902, Tishomingo folio (No. 98), 1903.

Stephenson, L. W., U S Geol. Survey, Prof. Paper 120, p. 145, 1918.

EAGLE FORD CLAY

NOMENCLATOR: R. T. Hill, 1887.

TYPE LOCALITY: Town of Eagle Ford in Dallas County, Texas.

CHARACTER: Dark blue or black shaly clay with thin sandstones.

THICKNESS: 300-400 feet in type section. Probably less than 10 feet in Oklahoma.

OCCURRENCE: North of Red River in southern Bryan County, Oklahoma.

AGE: Upper Cretaceous.

CORRELATION: Benton shale of northern Great Plains region. This formation not previously described in Oklahoma.

CITATIONS:

Hill, R. T., Am. Jour. Sci., 34th ser., vol. 33, p. 298, 1887.

BINGEN FORMATION

NOMENCLATOR: R. T. Hill, 1888.

TYPE LOCALITY: Town of Bingen, Hempstead County, Arkansas.

CHARACTER: The Bingen consists of sand, clay, lenses of gravel, and a bed of volcanic tuff. The tuff is exposed in the fertile belt of "red land" country that passes east through Idabel.

THICKNESS: 500 feet or more.

OCCURRENCE: The Bingen is exposed as a belt 3 to 8 miles wide paralleling Red River across southern McCurtain County into Arkansas.

AGE: Upper Cretaceous.

CORRELATION: Upper part of the Woodbine sand and the Eagle Ford of southern Oklahoma and northern Texas, and the lower part of the Austin chalk of Texas.

CITATIONS:

Hill, R. T., Ark. Geol. Survey, Ann. Rept. for 1888, vol. 2, pp. 56-58, 1888.
Miser, H. D., and Ross, C. S., Am. Jour. Sci., 5th ser., vol. 9, pp. 113-126, 1925.

THE PANHANDLE REGION

TRIASSIC (?) ROCKS

Certain exposures of red beds in Texas and Cimarron counties, Oklahoma, have been by some geologists referred to the Triassic. The exposures are as follows:

(1.) In Texas County, along the banks of Beaver Creek and Tepee Creek, near the old postoffice Redpoint, 12 to 20 miles west of Guymon. The rocks here are predominately red clays with occasional yellowish or gray bands and some ledges of soft red and gray sandstones. The total thickness is 15 to 20 feet.

(2.) In Cimarron County, along Cimarron River in the southern part of T. 6 N., R. 6 E., and in the northern part of T. 5 N., R. 6 E., about 20 miles northeast of Boise City. According to Rothrock the rocks are brick-red and buff sandstones in massive beds 7 to 10 feet thick, with fine conglomerates, and red shales. The total observed thickness is 20 feet.

It is the present opinion of the writer that the rocks in question are upper Permian (probably Cloud Chief formation), rather than Triassic. However, in deference to the opinions of other geologists, perhaps better qualified to judge, the beds are here tentatively referred to as Triassic.

CITATIONS:

Gould, C. N., U. S. Geol. Survey, Water-Supply Paper, 148, 1905.
Rothrock, E. P., Okla. Geol. Survey, Bull. No. 34, 1925.

MORRISON FORMATION

NOMENCLATOR: G. H. Eldridge, 1896.

TYPE LOCALITY: Town of Morrison, near Denver, Colorado.

CHARACTER: "Predominately green and gray clay, with beds of red and gray limestone, and variously colored sandstone."—Rothrock.

THICKNESS: 55 feet exposed.

OCCURRENCE: In the vicinity of Kenton, Oklahoma, along the valley of the Cimarron River and its tributaries Carrizo and Gallienas creeks, in T. 5 and 6 N., R. 1 and 2 E., northwestern Cimarron County.

AGE: The age of the Morrison is in question, being either upper Jurassic or basal Lower Cretaceous. No fossils have been

found in this formation in Oklahoma, but, on account of the fact that it has been traced down the Cimarron River from exposures in the Raton Mesa region, there can be no doubt that the beds in Cimarron County are of Morrison age. In Colorado and Wyoming the formation has yielded a large fauna of dinosaurs with a few primitive mammals and several genera of fresh-water mollusks and crustaceans.

CITATIONS:

Cross, Whitman, U. S. Geol. Survey, Pikes Peak folio (No. 7), 1894.
Eldridge, George H., U. S. Geol. Survey, Monograph 7, p. 60, 1896.
Stanton, T. W., The Morrison Formation, etc., Jour. Geol. vol. 13, pp. 657-669, 1905.
Stose, G. W., U. S. Geol. Survey, Apishapa folio (No. 186), 1912.
Lee, W. T., the Morrison Shales of Southern Colorado and Northern New Mexico, Jour. Geol. vol. 10, p. 43, 1912.
Richardson, G. B., U. S. Geol. Survey, Castle Rock folio (No. 198), 1915.
Mook, C. C., the Origin and Distribution of the Morrison Formation, Geol. Soc. Am., Bull., vol. 26, pp. 315-322, 1915.
Finley, G. I., U. S. Geol. Survey, Colorado Springs folio (No. 203), 1916.
Rothrock, E. P., Geology of Cimarron County, Okla., Geol. Survey, Bull. 34, 1925.

PURGATOIRE FORMATION

NOMENCLATOR: G. W. Stose, 1912.

TYPE LOCALITY: Canyon of Purgatoire River, southeastern Colorado.

CHARACTER: Lower 200 feet white to buff, largely cross-bedded sandstones with occasional ledges of conglomerate and some shale partings. The upper 50 to 75 feet consists usually of shale, variously colored, black, white and yellow, with sandstone beds. This shale carries an invertebrate marine fauna.

THICKNESS: Average 270 feet.

OCCURRENCE: The Purgatoire is exposed for a distance of about 35 miles along the Cimarron River and its tributaries in northwestern Cimarron County, Oklahoma, where, in connection with the overlying Dakota sandstone, it forms numerous bluffs, cliffs, and outstanding hills and mesas.

AGE: Upper Comanche (Lower Cretaceous).

CORRELATION: Upper part at least of the Washita group of southern Oklahoma and Texas, and the Kiowa shale of the Belvidere region, southern Kansas.

CHARACTERISTIC FOSSILS: (Lee and Stanton).

Gryphaea corrugata
Ostrea subovata
quadruplicata
Plicatula incongrua
Inoceramus comancheanus
Gervilliopsis invaginata
Pachydiscus brazoensis
Trigonia emoryi
Protocardia multilineata
Pholadomya sanctirabae
Turritella seriatim-granulata
Anchura kiowana
Hamites fremonti

CITATIONS:

Lee, W. T., the Morrison Shales, etc., Jour. Geol. vol. 10, p. 43, 1902.
Stanton, T. W., the Morrison Formation, etc., Jour. Geol. vol. 13, p. 657, et seq., 1905.
Stose, G. W., U. S. Geol. Survey, Apishapa folio (No. 186), 1912.
Lee, W. T., Geology of Raton Mesa, etc., U. S. Geol. Survey, Prof. Paper No. 101, p. 40, 1917.
Gould, C. N., U. S. Geol. Survey-Water Supply Paper 148. (In this paper the Purgatoire was erroneously included with the Dakota.)
Rothrock, E. P., Geol. of Cimarron County, Oklahoma, Okla. Geol. Survey, Bull. 34, 1925.

DAKOTA SANDSTONE

NOMENCLATORS: F. B. Meek and F. V. Hayden, 1862.

TYPE LOCALITY: Hills near Dakota, Dakota County, Nebraska.

CHARACTER: In general, buff-colored to brown or black, cross-bedded, massive sandstone. "A single sheet of sandstone of rather uniform thickness."—Rothrock.

THICKNESS: Averaging 65 feet.

OCCURRENCE: The Dakota is a formation of wide distribution on the Great Plains and in the Rocky Mountains of the United States and Canada. In Oklahoma it is exposed along the Cimarron River valley and on a number of tributary creeks in northwestern Cimarron County. Also in isolated patches in the valley of Beaver, Currumpaw, and Cieneguilla creeks in the southwestern part of the county.

AGE: The basal formation of the Upper Cretaceous.

CORRELATION: Woodbine sand of southern Oklahoma and Texas.

CHARACTERISTIC FOSSILS:

Arbietites ernestinae
Sassafras mudgii
Aralia formosa
Magnolia amplifolia

Sterucila mucronata snowii
Sequoia condita
Populus stygia
Myrica emarginata
Ficus crassipes
Alismophyllum victor-masoni
Salix flexuosa
Quercus groenlandica
Platanus guillelmae

CITATIONS:

Meek, F. B., and Hayden, F. V., Phila. Acad. Nat. Sci. Proc., vol. 13, p. 415-435, 1862.

Gould, C. N., the Dakota Cretaceous of Kansas and Nebraska, Kans. Acad. Sci., vol. 17, pp. 122-178, with bibliography, 1901.

Stanton, T. W., the Morrison Formation, etc., Jour. Geol. vol. 13, 1905.

Lee, W. T., Relations of Cretaceous Formations, Rocky Mts. of Colo. and New Mexico, U. S. Geol. Survey, Prof. Paper 95-C, p. 33, 1915.

Twenhofel, W. H., Geology and Invertebrate Paleontology of the Comanchean and "Dakota" Formations of Kansas, State Geol. Surv. of Kans., Bull. No. 9, bibliography, 1924.

Rothrock, E. P., Geology of Cimarron County, Okla., Okla. Geol. Survey, Bull 34, 1925.

SCATTERED CRETACEOUS OUTCROPS

Scattered throughout a number of counties in western Oklahoma one encounters isolated patches of "shell beds" consisting of ledges of fossiliferous limestone, the fossils being characteristic Cretaceous types. These beds are most abundant in Washita, Custer, Dewey, Woodward, Beaver, Harper, and Woods counties. The shell beds lie upon the eroded edges of Permian red beds, and are overlain in places by Tertiary rocks. R. L. Clifton, who has studied the fossils, correlates these scattered remnants with the Washita group of southern Oklahoma and Texas and with the Kiowa shale of southern Kansas.

CITATION:

R. L. Clifton, Unpublished Thesis, University of Oklahoma, Norman.

TERTIARY AND QUATERNARY

LATE TERTIARY ROCKS

Throughout a large portion of Western Oklahoma the surface rocks consist of a formation which has not received a definite name, but which is usually referred to by the general term "Late Tertiary." It was originally correlated with the "Loup Fork" of Nebraska. In Kansas, beds of probably the same age are referred to the Ogalalla formation of Pliocene and Miocene age, named by Darton in 1898 from Ogalalla, Keith County, western Nebraska. In Colorado the late Tertiary (Pliocene?) beds have been called the Nussbaum formation, this name having been proposed by Gilbert in 1897, from a spring near Pueblo.

CHARACTER: "A heterogenous mixture of clays, sand and gravel, often cemented by lime" (Rothrock), and known locally by many names, such as mortar beds, caliche, gyp, cap rock, pudding stone, and sheet-water rock.

THICKNESS: Variable up to 400 or even 500 feet.

OCCURRENCE: Occupies practically all the Panhandle counties and considerable parts of Harper, Woodward, and Ellis and other western counties.

AGE: Late Tertiary (Pliocene and Miocene).

Much discussed and little understood. Many articles have been written on the subject, but little careful work has been done in Oklahoma.

CITATIONS:

Hay, Robt., Water Resources of Great Plains, 16th Ann. Rept. U. S. Geol. Survey, pt. 2, p. 535, 1895.

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BASALT OF BLACK MESA

Near the northwest corner of Cimarron County there is a long narrow tongue of basalitic lava, extending into Oklahoma from New Mexico for a distance of four miles, averaging half a mile wide, which occupies the summit of a hill known locally as Black Mesa. The highest point in the State (5,050 feet?) is located in the center of the mesa one-half mile east of the New Mexico border. The igneous material is largely olivine basalt. Thickness averages 60 feet. It lies upon Late Tertiary deposits and is therefore late Pliocence or early Pleistocene in age, probably the former. Its sources are believed to be three spines or cores of igneous rock, known as Bar 7 L. Buttes, or Piney Mountain, located in southeastern Colorado some 10 miles to the west of the east end of the mesa.

CITATIONS:

Gould, C. N., U. S. Geol. Survey, Water-Supply Paper 148, 1905.
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TERRACE DEPOSITS AND DUNE SAND

In many parts of western Oklahoma, especially along the north slope of several of the large streams, there are considerable areas occupied by sand hills. The eastern limit of this sand along the various streams is to be found somewhere near the main north and south line of the Santa Fe railroad. The width of the sand hill area varies from a mile or less up to 20 miles. On going west the sand becomes more pronounced, and in western Oklahoma the sand hills merge with the Late Tertiary of the High Plains.

This sand has probably been derived from two sources. Part of it undoubtedly has been wind-blown from the stream to the south, being carried by prevailing south winds. On the other hand, it is generally believed that much, perhaps the greater part, of the sand in these regions represents the last vanishing remnant of the Late Tertiary deposits, which at one time probably covered practically all of western Oklahoma. The probability of the Tertiary origin of the sand hills is strengthened by the fact that throughout the region, and particularly in the lower part of the beds, there are large numbers of smooth, water-worn pebbles, composed largely of quartz, granite and other igneous rock, apparently identical with pebbles in the Late Teritary and which have usually been considered as having had their origin in the Rocky Mountains during Tertiary times.

CITATION:

Gould, C. N., U. S. Geol. Survey Water-Supply Paper 148, 1905.

GUERTIE SAND

NOMENCLATOR: J. A. Taff, 1899.

TYPE LOCALITY: Town of Guertie, southern Hughes County.

CHARACTER: Sand and gravel with alternating strata of clay and silt.

THICKNESS: 0-50 feet.

OCCURRENCE: Unconformable on the eroded edges of both Permian and Pennsylvanian formations on both sides of South Canadian River in McClain, Garvin, Pontotoc, Pottawatomie, Seminole, Hughes, Coal, and Pittsburg counties.

AGE: Probably Pleistocene.

CORRELATION: No satisfactory correlation of the Guertie has been determined.

CITATIONS:

Taff, J. A., U. S. Geol. Survey, 19th Ann. Rept., pt. 3, p. 439, 1899, Coalgate folio (No. 74), 1901.
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ALLUVIUM

All the large stream valleys throughout Oklahoma, and many of the creek valleys as well, are filled to various depths with alluvial material, including sand, silt, clay and marl, brought down by the streams. The valleys of the western streams in particular are filled sometimes to a depth of as much as 100 feet. This material is of recent origin and the process of its deposition is still in progress.

CITATION:

Gould, C. N., U. S. Geol. Survey, Water-Supply Paper 148, 1905.

SALT PLAINS

Salt Plains which occur in several regions in western Oklahoma are supplied with water from springs which issue from the Permian red beds. The largest plain is located in Alfalfa County, a few miles east of Cherokee. This plain which is 12 miles long

north and south, and 6 miles wide, lies in a basin surrounded by low hills. The geologic horizon is in the Enid, somewhere near the Duncan sandstone. The plain is as level as a floor and white as a snow field, being covered with an incrustation of salt crystals. This salt does not come from visible springs, but to use a common expression, "sweats up" from the floor of the plain.

Six other salt plains worthy of note are located as follows: Two along the valley of Cimarron River between Woods and Harper counties, one in north-central Blaine County, one in southeastern Beckham County, and two in northern Harmon County. All these plains are located in valleys along the Gypsum Hills, and are spring-fed, the water in each case coming from the same geologic horizon, namely, the Chickasha formation or upper part of the Enid formation, and just below the Blaine. These plains vary in size from a few acres to more than one square mile each. The amount of water issuing from these various springs is estimated to be sufficient to manufacture 100 car loads of salt per day, none of which, at this writing, is being utilized.

CITATIONS:

Gould, C. N., U. S. Geol. Survey, Water-Supply Paper 148, pp. 100-104, 1905.

Snider, L. C., Okla. Geol. Survey, Bull. 11, 1913.

FINDING LIST OF AUTHORS

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